

EDUCATION IN THE FIELD
OF MATHEMATICS IN THE USSR

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Chapter I

INTRODUCTION

Background that led to the study

The best clue to the understanding of a nation, of its will, its purpose, and the probability of its realizing its purpose, in whole or in part, is to be found in the way it educates its children. The Soviet Union has changed the entire mentality of the Russian people in a single generation, an accomplishment that is probably without parallel in history. Russian educators believe that every child unless physically or mentally abnormal is educable at a very high level, provided he can be put and kept in a frame of mind and under a discipline that persuades him to accept and cooperate with his education.

The profound economic, political, social, and cultural transformations which have taken place in Russia during the last few decades are of great interest to the Western world. It is a well-recognized fact that for twenty-five years the USSR has made immense efforts toward the elimination of its economic backwardness and toward the increase of its industrial, military, and political power. For the achievement of these aims, the Soviet Union has concentrated heavily on scientific and technical education, on the elimination of illiteracy, on the wide diffusion of technical knowledge, and on the strengthening of the political loyalty of its citizens. For the last twenty years, under

the slogan that cadres decide the outcome of everything, the Soviet Union has proceeded with the build-up of its skilled labor and of its professional value and specialized technical manpower resources. It was realized that the success of these efforts was a necessary condition for industrial development, technological advance, and ultimately, military and political power.

The Soviet educational system is designed to meet the needs of the State, not the needs of the individual. The system has two predominant goals: first, to produce trained specialists to meet the demands of the expanding State economy; second, to produce graduates with the correct political orientation, that are loyal and unquestioning believers in the government and in Communism. Lenin insisted that Soviet schools should give not only a wide general education but also introduce a political partisan note suitable for a period of class struggle. He said: "Our business in the academic sphere is also the struggle for the overthrow of the bourgeoisie; we openly announce that a school divorced from the life and politics is a lie and a hypocrisy."¹

As it is not the individual around whom the educational system is built, but the State. The State, therefore, identifies itself with the pursuits of the common good, attempts the ruthless subordination of the individual, his rights, tastes, choices, privileges, and his training, to its own needs. The substitution of the service-to-the-State notion for concepts of individual benefit or profit is the fundamental distinctive feature of Soviet educational philosophy and actual

¹v. I. Lenin, Sochineniya (3rd ed., Moskva: Gosudarstvennoe Sotsial'no-Ekonomicheskoe Izdatel'stvo, 1931), XXIII, p. 199.

educational policies. Communist education does not limit itself to instruction, but embraces the entire field of character training and the formation of attitudes, sentiments, and beliefs. This broader aim of the Soviet educational system is viewed as an attempt to create the new Soviet man. Reduced to its fundamentals, Soviet educational philosophy rests on three major premises.¹ The first of these is that the advancement of science and technology is best promoted through the central planning of education and research. The second is that scientific and educational efforts are primarily a means for the advancement of the social, economic, political, and military interests of the nation. The third is that the basic truths of human life, of nature and of the universe, and of social, political and economic reality, have been discovered and proclaimed and are beyond debate, so that the task of the teacher and of the scholar is to demonstrate and to apply these truths rather than to question them or to seek alternative truths. In such a system mere ideological conformity is not enough. Professional competence and applied technical know-how are also necessary. The character and kind of training are determined by the simple and obvious necessity for various types of trained manpower, scientists, engineers, managers, teachers, supporting personnel, and skilled labor. There is a demand for trained manpower, regardless of whether individual members have or have not been thoroughly indoctrinated, whether they sincerely conform to or only outwardly embrace Communist dogma. In order to meet the growing demand for specialized

¹H. Berman, "The Right to Knowledge in the Soviet Union," Columbia Law Review, LIV (May, 1954), pp. 749-764.

and skilled manpower, Soviet educational policy has been increasingly more heavily aimed, at all educational levels, toward the promotion of those types of training which stress concrete knowledge. Because of this stress the rational-technical feature became one of the prominent aspects of Soviet education. Stress on the mastery of specific subjects and on the acquisition of technical and scientific skills has become dominant in all fields and on all levels of the educational system.¹

In this space age of Sputniks and Explorers the current Soviet policy is to direct the development of its science and technology toward achieving supremacy, militarily, politically, and economically over the West. The Soviet leaders have considerable insight into the potentialities of science as an essential aid to technological progress. The Soviet government and the Communist Party are convinced that leadership in science means leadership of the world.

Against this background of an educational policy heavily inclined toward science and technology, a Communist ideology of the State first, the individual second, and a desire to surpass the West, against this, the problem of this study is formulated.

Statement of the problem

The problem of this study is to present a picture of mathematics education in the USSR. A proper understanding of the importance of

¹B. Moore, Terror and Progress, USSR (Cambridge: Harvard University Press, 1954).

mathematics education in the USSR education program can be gained only if viewed against the backdrop of the entire educational program. The educational system of the USSR is discussed in some detail including such topics as the evolving educational philosophy, from prior to 1917 to the present day, and the educational differences among national groups, pointing out the complexity of having over 170 different minority groups speaking more than 125 different languages and dialects. The general structure of the educational program is discussed including the administration of the educational program, its organization and operation, and the different types of schools, such as schools for the working youth, evening and correspondence schools, and schools for the artistically gifted as well as those for the sick and handicapped. A brief description is included on vocational training both on the lower and technical level. The semiprofessional schools (technicums) are discussed in some detail. Included also in this general discussion are the characteristics of the present day Soviet educational system including the philosophy, aims, and functions.

The next consideration is the mathematics curricula as presented in the elementary and secondary schools. Included in the discussion are such topics as the universal curriculum, textbooks, and courses including the content and time required. The content of the courses, kindergarten through the tenth grade, are discussed in some detail giving the subjects taught, when they are taught, and the number of hours devoted to each. Included also is an estimate of the per cent of time that is utilized on the separate subjects. An indication is given as to the control of the curriculum, equipment in the classrooms, curriculum flexibility, and examinations.

Such a study would necessarily include a discussion of the training of a mathematics teacher. Under this heading the background and the adequacy of the supply of teachers is indicated with a short discussion of the administration, teacher-training institutes, including pedagogical secondary schools, pedagogical institutes, universities, and teacher's institutes. In-service training for teachers is discussed to a considerable extent. Included also are such topics as the curriculum, methods of instruction, certification, conferences, trade unions, exhibits, and the research program for prospective teachers.

Such a study would not be complete without a discussion of the teacher at work. Under this heading are covered such topics as teaching methods, conditions under which the teachers work, including such items as student-teacher ratio, discipline, influence of Communist youth organizations, and the supervision of inspectors. Also are included comments on the grading scheme, the teaching load of the Soviet teacher, the teacher and his leisure time, and discipline as a major factor in the teacher's life. The procedure for appointing a graduating student to a teaching position is indicated. Comments on his promotion, tenure, and prestige are included.

Data used in the study

The Library of Congress has a large number of Soviet books containing the decrees and resolutions underlying the Soviet educational structure, and a fairly complete collection of major Soviet education journals, periodicals, and such basic reference materials as statistical compendiums, handbooks for Soviet students, and the descriptions of the school system as a whole or special parts of it. Among the experts on

the Soviet Union, there is a general consensus that in spite of some official exaggerations and distortions, it is possible to penetrate Soviet data. Considerable care must be exercised in obtaining facts and in making generalizations and interpretations of facts from official Soviet sources. Soviet statistical data are full of perplexities and pitfalls which must be considered among the very basic difficulties in the way of getting facts about Russia.¹ The Soviet government does not falsify those statistics which it elects to publish.² Contrary to some belief, the Russians seem generally not to resort to falsification in the sense of free invention and double bookkeeping.³ It is commonly agreed that data obtained from official Soviet pronouncements and statistical publications have some meaning and significance. Articles in the Soviet press provide supplementary data. While propaganda pamphlets or official speeches may present glowing accounts of educational achievements, Soviet educators writing for their own people frequently are self-critical. Magazine articles and newspaper accounts written for home consumption often reveal discrepancies between official education policies and actual practices. A careful analysis of these day-to-day reports by educators, parents, students, and the Communist Party administrators and planners reveals many areas of disagreement and gives insight into Soviet thinking about educational problems as well as some kind of concept of the realities of Soviet school life.

¹A. Bergson, "A Problem in Soviet Statistics," The Review of Economic Statistics, XXIX (November, 1947), p. 234.

²Ibid.

³A. Bergson, "Reliability and Usability of Soviet Statistics," The American Statistician (June-July, 1953), p. 19.

caused by the lack of data.

which had appeared in open publications. The greatest difficulty was 1941, seized by the Germans and later published, agree well with information World War II are consistent with pre-war trends. Classified data for statistical compilations published for Soviet use in planning. Data since that the pre-war data are taken largely from comparatively detailed In regard to the reliability of the data it must be pointed out available.

and students who had visited the USSR and later made their findings Also taken into account are studies compiled by specialists, educators, policies and practices and on changes contemplated for the near future. with phases of Soviet education revealed information on current educational Conversations with several Soviet educators and officials associated at otherwise unjustified claims of extraordinary success.

order to conceal unfavorable trends or to give Soviet propaganda a chance 1955-56. There are some sudden aggregations of distinct categories in included. Also 1955 could mean mid-year 1955 or academic 1954-55 or even all secondary students of special, technical, and labor schools are In some cases only the regular schools are included while in other cases discrepancy is due largely to various definitions of secondary schools. schools for 1955 vary greatly from one report to another. This seeming of reporting. For instance, the enrollment figures in the secondary changing definitions with occasionally appearing ambiguities as to dates there is occasional juggling with statistics. There is the problem of statistics in that there is no evidence of out-and-out fraud. Of course, The opinions of the experts agree in regard to Soviet educational

Data were collected freely from many of the professional journals. These journals included, Mathematics in the School, Herald of the Higher School, Primary School, Preschool Education, and The Family and the School. The triweekly newspaper, Teacher's Gazette, is a comparatively good source of data. The monthly journal, Soviet Pedagogy, the organ of the RSFSR Academy of Pedagogical Sciences, proved to be of particular value. This journal contains articles written by the most respected educators and pedagogical authorities of the Soviet Union. Its sections cover a wide variety of fields from general educational theories and practices to the history and development of ideas, book reviews, articles on teacher-training and practice teaching of education majors.

Assumptions and definitions and limitations of the study

In this study mathematics education is considered for the grades from the nursery and kindergarten through the tenth grade. Higher education, universities and institutes, is considered only from the aspect of the training of prospective teachers. Mathematics education in this study is set against a background of the Soviet educational system, and includes a discussion of the various schools up through the tenth grade, the curriculum of these schools, the training of the teachers for these grades, the teacher at work and a summary of the trends of education. In presenting education in its Soviet setting, there is pointed out various influences on education such as size of country, diversity of peoples, the government system, and Soviet administrative and organizational measures developed to run the schools and training programs. Attention is focused on various levels of education and related subjects, namely, preschool education, general primary-secondary education, auxiliary primary-secondary schools,

extracurricular work-activities, vocational training, semiprofessional training, and the teaching profession.

Other studies in this field

There have been a number of scholarly books and monographs dealing with Soviet educational policy and practice, either specifically or in relation to more general problems of political, social, or cultural development in the USSR. Many periodicals and newspaper editorials, particularly in the last few months, since Sputnik and Explorer, have appeared in the Soviet and United States press. "The New Education in the Soviet Republic," 1929, by A. P. Pinkevitch was one of the best early works in this field.¹ Beatrice King's "Changing Man," 1936,² followed by her second book some twelve years later, "Russia Goes to School,"³ were some of the outstanding early discourses in this general field of Soviet education.

In M. J. Shore's, "Soviet Education: Its Psychology and Philosophy," it was observed that Soviet educational philosophy and actual educational policy had their origins in the Marxist theory of education and their adaptation in the doctrines of Soviet ideology.⁴ Approximately a decade ago, G. S. Counts and N. Lodge contributed to this general area with

¹A. P. Pinkevitch, The New Education in the Soviet Republic, ed. G. S. Counts (New York: The John Day Co., 1929).

²Beatrice King, Changing Man (London: V. Gollanoz, Ltd, 1936).

³_____, Russia Goes to School (London: William Heineman, Ltd, 1948).

⁴M. J. Shore, Soviet Education: Its Psychology and Philosophy (New York: New York Philosophical Library, 1947).

their two volumes, "I Want to be Like Stalin,"¹ and "The Country of the Blind."² In the latter book it was stated that Soviet education was primarily a weapon of Communism and that it was used predominantly as an instrument for achieving political conformity.

The institutional role of the Communist Party and its impact upon the Soviet educational structure and policy was an important theme of Widmayer in his thesis, "The Communist Party and the Soviet Schools, 1917-37," published in 1952.³ In 1950 Johnson published his, "Russia's Educational Heritage," in which he extensively explored the history of Russian education and the West European influences upon it, and the subsequent influence of this heritage upon Soviet educational institutions and practice.⁴ The emergence of the totalitarian state in the Soviet Union and its impact upon educational practice was explored rather thoroughly by Fainsod in his book, "How Russia is Ruled," published in 1953.⁵ Baur in "The New Man in Soviet Psychology," discussed the general problem of Soviet psychology and its complex

¹G. S. Counts, and N. Lodge, I Want to be Like Stalin (New York: The John Day Co., 1947).

²G. S. Counts, and N. Lodge, The Country of the Blind (Boston: Houghton Mifflin Co., 1949).

³R. Widmayer, "The Communist Party and the Soviet Schools, 1917-37" (unpub. Ph.D. Thesis, Harvard, 1952).

⁴W. H. E. Johnson, Russia's Educational Heritage (Pittsburgh: Carnegie Press, 1950).

⁵M. Fainsod, How Russia is Ruled (Cambridge: Harvard University Press, 1953).

relationship to Soviet educational aims, and the dilemma of Communist attempts to create the new Soviet man.¹ Hulicka, 1953, in "Political Education in Soviet Schools" emphasized that the political aspects seemed to dominate every level of education in the USSR.² The problems of education and cultural life in the USSR were analyzed under the impact of the emerging bureaucratic power structures by Rostow in "The Dynamics of Soviet Society."³ Education itself has become a powerful factor in social stratification and mobility, and, as a consequence, extensive and keen competition for the opportunity to continue education was pointed out by Koutaissoff in "Soviet Education and the New Man," 1953.⁴ Soviet educational policy has been analyzed in the light of political, rational-technical, and traditional elements by Moore in "Terror and Progress."⁵ Nicholas DeWitt gave a rather detailed statistical analysis of Soviet manpower in "Soviet Professional Manpower, Its Education, Training, and Supply."⁶ The most up-to-date publications

¹R. Bauer, The New Man in Soviet Psychology (Cambridge: Harvard University Press, 1952).

²K. Hulicka, "Political Education in Soviet Schools," Soviet Studies, V (1953), p. 2.

³W. Rostow, The Dynamics of Soviet Society (New York: W. W. Norton & Co., Inc., 1953).

⁴E. Koutaissoff, "Soviet Education and the New Man," Soviet Studies, V (1953), pp. 122-123.

⁵Moore, op. cit., p. 208.

⁶National Science Foundation, Soviet Professional Manpower, Washington: US, GPO, 1955.

in this field are those of George S. Counts in The Challenge of Soviet Education, 1957,¹ the U. S. Department of Health, Education and Welfare Bulletin on Education in the USSR, 1957,² and Korol's book, Soviet Education for Science and Technology, 1957.³

The studies mentioned above have all been in the more general field of education. None have been pointed specifically at the present problem of presenting a picture of mathematics education in the USSR. Thus, it is hoped that the present study may fill a gap in our knowledge of the educational system of the Soviet Union.

The order of presentation

This study has been organized into six chapters, the first being the present one on an introduction to the problem. Chapter II, The Educational System of the USSR, deals with the evolving educational philosophy, individual opportunity, educational differences among the national groups, the general structure, and administration of the educational program. It includes a discussion of the different types and kinds of schools, and the characteristics of each. It concludes with a summary of the philosophy, aims, goals, and trends in education. This is followed by Chapter III, The Mathematics Curriculum. This chapter includes a discussion of the curriculum, its content, subject matter, textbooks,

¹George S. Counts, The Challenge of Soviet Education (New York: McGraw-Hill Book Co., Inc., 1957).

²U.S. Department of Health, Education and Welfare, Education in the USSR, Washington: US, GPO, Washington 5, D.C., 1957.

³Alexander G. Korol, Soviet Education for Science and Technology (New York: Technology Press of MIT and John Wiley & Sons, Inc., N.Y., 1957).

control and supervision of the curriculum, examinations, and recent trends in this field. Chapter IV is on the training of mathematics teachers and includes the background and adequacy of the supply. It includes a discussion of the administration of teacher-training and a rather detailed description of teacher-training institutions. Included also is a description of the curriculum and the methods of instruction in the teacher-training institutions. There is also included a brief discussion on certification, teacher's conferences and trade unions, research facilities, a summary, and trends in this field. This is followed by Chapter V, The Teacher at Work. In this chapter are included such things as teaching methods, conditions under which the teachers work, the teaching load, discipline problems, promotion, salary, and tenure followed by a paragraph on summary and trends in this area. Chapter VI attempts to summarize the entire discussion of the problem and to indicate the recent trends in education and mathematics education.

Chapter II

THE EDUCATIONAL SYSTEM OF THE USSR

Evolving Educational Philosophy

Prior to 1917 the Russians considered education as a middle class device by which they educated themselves and their own children in order to insure their continuing rule and domination over the masses. The schools were few and were to be found only in the towns. The hostility of the government was quite plain as revealed in 1915 by the statement of the Minister of Instruction, Shishdov: "Knowledge is useful only when, like salt, it is used and offered in small measures according to the peoples' circumstances and their needs. To teach the mass of people, or even the majority of them, how to read will bring more harm than good."¹ On another occasion a government member said: "Children of the wealthy classes should be protected from an influx into the schools of children of the poor and middle classes."² By 1914 an optimistic estimate was that about half of the Russian children of primary school age were going to some sort of school. There was the prevailing feeling that the Russian peasantry must be lifted out of its backwardness, ignorance, and superstition. Education was vital to the survival of the society. Illiteracy in the USSR was reported to be between 60 and 70 per cent.

¹King, Changing Man, op. cit., p. 92.

²Ibid.

By 1917 the Communist Party held to the belief that education for all was important. They stated that when they came into power they would make education, including university training, open to everyone. Education could serve the Party by increasing the technical efficiency of the new society and by replacing the existing ideologies by that of Communism.

By 1917 the educational system was in a state of expansion. Many educators in Russia desired to introduce the new educational ideas then being discussed in the western world. These included giving the child more freedom in the classroom and, in general, on abandoning the authoritarian teaching methods. These early days were the days of great freedom for education. Educational experimentation was not only encouraged but was compulsory.

Every possible educational plan was considered. The Dalton and Project Method were judged good, however, the plan, as presented by Helen Parkhurst, was too individualistic for a socialist country. During this time of experimentation, however, Soviet educators were not idle. Observations of the educational processes and research were being conducted by departments in the pedagogical institutes. Gradually order evolved out of chaos. It was not until the early 1930's, however, that the experimental methods were forsaken in favor of the traditional methods of education used in Tzarist Russia.

The prevailing idea in the 1930's was that the development of the country depended upon raising the educational level of the people and making the USSR a more literate nation. In order to create the technical-scientific base upon which depends the development of the country and the resultant consolidation and expansion of Communism, the USSR considered it necessary

to initiate and carry out a tremendous program of education and training. Consequently, throughout the years of the Soviet regime the education and training of Soviet scientific manpower has received paramount emphasis.

Soviet education can be assessed in terms of functions which the Revolutionary leaders wanted education to perform for the new society. If there is one single guiding idea behind the Soviet thinking concerning the Soviet educational system, it is probably the statement of Lenin's: "We cannot limit ourselves to Communist slogans. You will not build up socialism like that. You will be Communists only when you have enriched your minds with the knowledge of all the wealth that humanity has created If I know that I know little, I will endeavor to know more. But, when anyone says he is a Communist and so does not need a solid foundation of knowledge he is not, and never will be, anything approaching a Communist."¹ And so to these Revolutionary leaders education was a dual purpose instrument of social change. One aim was the conversion of a semiliterate peasant people into a literate army of skilled technicians required for the new industry. The second was the cultivation of an idealistic, dedicated citizenry motivated to make sacrifices for material progress and for socialism. These complementary goals in their sweeping program of change were to be achieved by a program of universal, free education aimed at wiping out all inequalities of access and opportunity. Accordingly, after the Revolution, and especially with the onset of the five-year plans, the educational system was tremendously and steadily expanded.

¹Xing, Changing Man, op. cit., p. 111.

The results of this expansion are seen in the greatly extended availability of education and the consequent shrinking of illiteracy to a minor segment of the population. Educational levels have been sharply raised with an effective seven-year minimum virtually achieved, an impressive conversion of a semiliterate people in one generation. While education has been expanded and a seven-year schooling generally approached as an effective minimum, education has increasingly taken on the narrow cast of technical and vocational training in order to provide skilled and professional workers for the vastly expanded industrial economy of the Soviet Union.

Educational differences among national groups

In the USSR there have been several obstacles to the expansion of technological education. For instance, there are 177 different minority groups, speaking more than 125 languages and dialects and worshipping in some forty different religions. These national groups have lived side-by-side for thousands of years, all the while struggling to maintain ethnic unity, clinging to tribal customs and national traditions. The Soviet State has organized these minority groups into sixteen Soviet Socialist Republics, nine autonomous regions (oblasts), and ten national districts (okrugs).¹ Educational differences among national groups have not been eliminated. The greatest differences still separate the minor nationalities (non-Slavic Soviets and others) from the three major western groups (RSFSR,² Ukrainians, and Belo Russians). The RSFSR Russians are slightly better educated than the others, followed by the Ukrainians and the Belo Russians (Table 1). By contrast, about one-half of the minor

¹U.S. Dept. of Health, Education and Welfare, op. cit., p. 7.

²Russian Soviet Federated Socialist Republics.

nationalities have only a primary schooling, and only about one-fourth of them have completed ten years or more. Thus, they have not achieved educational equality with the western nationalities. The problem of numerous strong national minorities (Armenians, Georgians, Kirghiz, Kazakhs, Uzbeks, Buryat-Mongolians, Finns and the Manchurians) remains a constant one of the Soviet regime, and measures continue to be taken to achieve Communist Russification.

TABLE 1
AREA, POPULATION, AND ENROLLMENT BY EDUCATION LEVELS
IN SOVIET REPUBLICS IN 1955¹

Republic	Area in square miles ²	Estimated population April 1956 in millions	Enrollment, in thousands, in:		
			Primary-secondary schools	Semiprofessional schools ²	Higher institutions
1	2	3	4	5	6
TOTAL, USSR	7,877,598	200.2	30,070.2	1,960.5	1,867.0
RSFSR	5,525,090	112.6	16,303.2	1,193.6	1,171.9
Ukrainian SSR	232,664	40.6	5,882.0	374.6	325.9
Belorussian SSR	80,154	8.0	1,289.7	60.1	50.5
Others	2,039,690	39.0	6,395.3	332.2	318.7

¹New York World-Telegram and The Sun, *The World Almanac 1957* (New York: The World-Telegram and The Sun, 1957) pp. 440 and 442.

²Tsentral'noe Statisticheskoe Upravlenie pri Sovete Ministrov SSSR, *Narodnoe Khozyaistvo SSR: Statisticheskii Sbornik* (Moskva: Gosudarstvennoe Statisticheskoe Izdatel'stvo, 1956) pp. 18, 226, 231, 232.

General structure of the educational program

The USSR is a large country with people living in widely separated areas. In the far north there are pupils with cultural traditions akin to those of the Eskimos. Throughout Central Asiatic Russia, many pupils are from Moslem cultures and speak entirely different languages. Then there are other smaller minority national groups with differing needs, motivations, traditions, and environments. In a country of so many and varying contrasts, effecting absolute centralization of education is difficult.

Administration of the educational program

Although there is no single federal ministry of education, the educational system of the USSR is highly centralized and control is retained by the Party and State. Operational responsibility for education has been delegated until it rests on local communities and groups.

Guiding directives on education are discussed at Communist Party Congresses and in meetings of its Central Executive Committee. The USSR Council of Ministers promulgated the laws and resolutions having significance for the general educational development of the whole country. The Party is often the co-signer of such laws. Such decrees and resolutions specify types of rules to be established, basic organization, academic programs, and general provisions concerning compulsory education.

Of importance in the administration of Soviet education is the surveillance maintained by the secret police on the political reliability of administrative personnel, teachers, students, and others from the highest to the lowest in rank. The major governmental organs concerned

with the schools include the Union-Republic Ministry of Higher Education, the Ministries of Education in the Soviet Republics, the Chief Directorate of Labor Reserves under the USSR Council of Ministers with local branches subordinate to the republics councils of ministers, and the Union-Republic Ministry of Culture with subordinate ministries in culture in each of the republics.

General or nonspecialized education along with most of the teacher-training for kindergartens and primary-secondary schools is administered by a republic ministry of education in each of the Soviet Republics. The training of elementary and secondary school teachers in pedagogical institutions, teacher institutes, as well as advanced degree training in education, are administered by the sixteen republic ministries of education.

The radical differences between the Soviet administration of education and that of Western Europe or the United States are obvious. In the Soviet Union, important educational policy decisions are reached not by individual educational establishments but by central bodies of the Soviet governmental structure. Individual educational establishments grouped together under certain branches of the educational administration have only limited autonomy in reaching the day-to-day operational decisions. Such decisions are merely tools in the implementation of a certain aspect of educational policy and the over-all educational effort remains centrally co-ordinated and centrally supervised.

Organization and operation of the educational program (Fig. 1)

The regular educational system in the Soviet Union falls into two categories - general and technical. General education is offered at three levels. The first four years of school are classed as primary.

They are compulsory, free, and universal. Children enter at the age of seven. The second level is the incomplete middle (seven-year) school which includes the first four grades plus grades five through seven. The third level is the complete middle (ten-year) school which includes the four grades of the primary school, the three years of incomplete middle school, and three additional years. The standard regular primary-secondary school program in each of the Soviet Republics is for children between the ages of seven and eighteen. It is divided into three stages which somewhat approximate the elementary and secondary levels of education in the United States. In the USSR the three stages are not grouped into separate schools by educational levels as they frequently are in the United States. The same curriculum is covered in Grade III, for example, whether it is located in a four-year, a seven-year, or a ten-year school. Completion of this course leads to the certificate of maturity, which entitles the student to apply for entrance to a university or institute.

Although the ten-year school is the standard primary-secondary institution for general education in the USSR, other organizational patterns have been devised for non-Russian speaking children. In some non-Russian speaking republics the schools are based on a four-four-three pattern, with the extra year providing for the study of the Russian language. In other non-Russian speaking schools, extra time to study Russian is provided through a lengthened school day and year.

The academic year in Soviet primary-secondary schools is divided into four quarters with an additional period set aside for review and final examinations. Schools open early in September and close in late

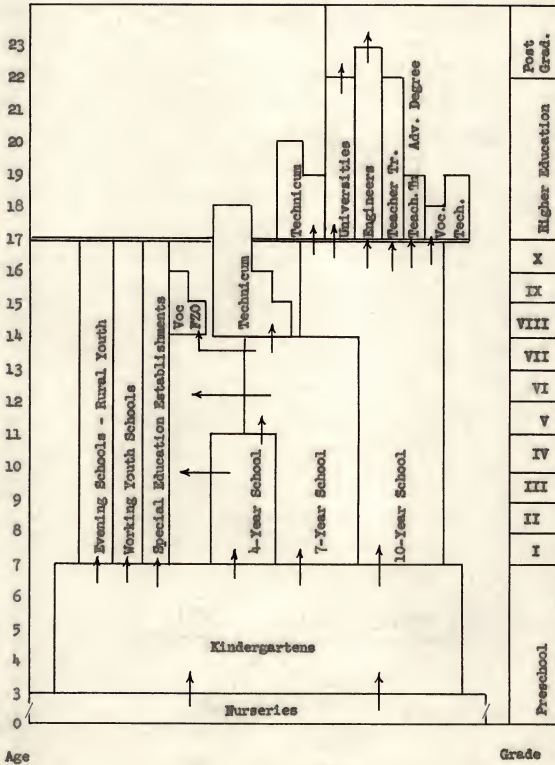


Fig. 1.--Organization and Operation of the Educational Program

May, for Grades I - III and later in June for other grades. Lessons are scheduled for forty-five minutes. The schedule of lessons consists of: twenty-four hours a week for the first three grades, twenty-six hours of class instruction for Grade IV, thirty-two hours for Grades V through VII, and thirty-three hours for Grades VIII through X.

Several kinds of general educational programs are geared to meet special needs. They cover approximately the same curriculum as is required at the different levels of the regular schools. Among these are schools for working youth, schools for the exceptionally bright, evening schools for rural youth, correspondence secondary schools, the military schools, schools for the artistically gifted, schools for the sick and handicapped, labor reserve schools, and vocational technical schools.

Separate from and at an academic level between general education schools and higher educational institutions (universities and institutes), and to a certain extent over-lapping them, lies a series of middle special schools, often called technicums. There are of varied types and levels, corresponding roughly to American technical high schools and junior colleges.

Technicums cover a wide variety of specialities, preparing nurses and midwives, mechanics, electricians, librarians, junior legal assistants, and primary-school teachers. The term of instruction varies from two to five years, depending upon the specialty.¹ The most common type of technicum, however, corresponds to Grades VIII to X of the complete

¹E. N. Medynskii's, "Srednee Professional'noe Obrazovanie," Narodnoe Obrazovanie v SSSR (1952), pp. 143-153.

secondary school. It accepts students of both sexes aged fourteen to thirty, who have completed the seven-year school and who successfully pass entrance examinations on mathematics, Russian language and literature, and the USSR Constitution. This type of school, though a special school, is required to include in the curriculum the same subjects covered by the complete secondary school so that a graduate will have approximately the equivalent of a ten-year general education as well as knowledge of his speciality. However, the technicum training is extremely narrow and specialized. The aim is to graduate experts in one very narrow field. The general educational background is merely fitted in as best as possible, the large part of the regular secondary school curricula's theoretical side is covered only vaguely or omitted altogether.

All satisfactory technicum students receive stipends ranging from 80 to 200 rubles per month, in special cases somewhat more. Students rated as outstanding receive a bonus of 25 per cent.

Technicums are normally looked upon as a substitute for university work, as a means for the acquisition of a life profession. The law stipulates that graduates must spend the three years following graduation working in the specialty in which they have been trained. The universities and institutes are not completely closed to them, however. The top 5 per cent of technicum graduates (less than 4 per cent of the annual admission to higher educational institutions) may be admitted directly without taking the entrance examinations and without having to work the three mandatory years required by law for an institute specializing in the same field as the technicum. But in actual practice, it is almost impossible for a graduate of a technicum to enter a higher educational

institution, particularly a university. The courses at a technicum are so specialized that it is almost impossible for such a graduate to pass the standard university entrance examinations in competition with ten-year school graduates who have had the general education designed especially to prepare them for work in a higher school.

Characteristics of the present-day Soviet educational system

One of the underlying principles that guides Communist education is revealed in the statement of Lenin's: "The school apart from life, apart from politics, is a lie and hypocrisy."¹ The editors of the great Soviet encyclopedia, now reporting directly to the top council of ministers, further summarize the aims in Soviet education as follows: "To develop in children's minds the Communist morality, ideology and Soviet patriotism; to inspire unshakeable love towards the Soviet fatherland, the Communist Party and its leaders; to propagate bolshevik vigilance; to put an emphasis on atheist and internationalist education; to strengthen bolshevik willpower and character, as well as courage, capacity for resisting adversity and concurring obstacles; to develop self-discipline; and to encourage physical and esthetic culture."²

There are several major characteristics of the primary and secondary education in the USSR:³

¹King, B., Changing Man, p. 90 (see also p. 2).

²USSR, Great Soviet Encyclopedia (1948) (Kairov; RSFSR Minister of Education; now President, Academy of Pedagogical Sciences).

³N. Hans, Comparative Education (London: Routledge & Kegan Paul, Ltd., 1949) p. 214.

- (1) the monopoly of the State over all educational practices;
- (2) the separation of church and State (This is applied rather strictly to the schools. The role of the extracurricula activities sponsored by the youth organizations of the Communist Party, the Pioneers and Komsomols, work actively with the youth to inculcate them with the aims and ideals of the Communist Party, which, needless to say, disapproves of the traditional role of the church as known in the Western world.);
- (3) an introduction to productive work as an integral part of training;
- (4) the presence of physical and military training;
- (5) political indoctrination both in and out of school through partisan youth organizations;
- (6) extensive emphasis of scientific subjects at all levels of training (During the years of the Soviet regime, the education of Soviet scientific man power has received top emphasis.);
- (7) universality of education opportunity (The Soviet Constitution guarantees everyone an education. Article 121 of the Constitution of the USSR states that right.);¹
- (8) unity of the educational system (It is so organized that the various types of levels of schools form a steady progression from primary through university and post-graduate study.);
- (9) racial and national equality (Education is conducted in the native tongue in all republics and regions.);
- (10) absolute equality of men and women (Students in Soviet higher schools comprise just about 50-50 men and women; some fields with a preponderance of women students such as education, 80 per cent women, and medicine, 60 per cent women, balance other areas, such as various technical sciences, 30 to 40 per cent women.);
- (11) internationalism and its complement, Soviet patriotism (This means teaching respect for all peoples. The study of world

¹U.S. Dept. of State, op. cit., p. 10.

history and foreign languages is begun in the primary school while emphasising how superior the Soviet way of life is with its opportunity for the common worker.);

- (12) education as a means of transformation from Socialism to Communism (The Party has used education as a weapon for making this transition. To maintain the technical-scientific foundation upon which depends the development of the country resulting in the strengthening of Communism, the Party has marked it imperative to start and maintain a gigantic program of education.)

The underlying theme of the above named characteristics is that the Marxian Doctrine, augmented or modified in day-to-day interpretations by the central bodies of the Communist Party of the Soviet Union, continues to be the dominant factor in Soviet educational policy. No religion, no private schools of instruction, no ideas alien to Soviet official dogma are tolerated in Soviet primary and secondary education.

It would be a serious mistake to assume that Soviet education consists entirely, or even largely, of Communist indoctrination. By any standard, the educational achievements of the Communist regime have been impressive. The most striking of these has been the virtual elimination of illiteracy among people under forty. In its issue of October 30, 1955, Pravda claimed that 60,000,000 Russians are now going to school, adult classes included.

Soviet policy precisely enunciates the function of education in the USSR, namely, to serve the needs of the State. To its full development every person is expected to contribute his best efforts as his primary obligation. The growth and development of his own individuality are of secondary importance. Soviet education aims at education for excellence with freedom of choice resting with the State to the end that the State may be developed to the optimum.

Underlying such achievements as orbiting satellites and advanced rocketry is a remarkable story of stepped-up education in the natural sciences and mathematics. Today, as earth satellite vehicles continue to circle the earth it is quite evident that the Soviet government and the Communist Party are convinced that the world has been shown the result of the Russian primary, secondary and higher schools having put major emphasis on mathematics and science. Perhaps nothing in the last decade has so emphatically pointed the finger to the importance of mathematics as a basis of science as the orbiting satellites. The Soviets are first to admit the importance of mathematics in scientific development.

↘ Structure of the present-day Soviet educational system

To some extent the educational problems in the USSR and in the United States are similar. Both nations are committed to the principle of universal education; both have many differing racial and cultural traditions within their borders; both have large land masses with great diversity of climate and topography, crops and industries; and both have educational programs for training millions of people.

The USSR has claimed an educational program available for all ages from the cradle to the grave for rural and urban dwellers, for rich and poor. By adding the informal or part-time courses on the job and in the Party network as well as the school programs, more than sixty million children, youth, and adults are enrolled in some sort of program. Many millions more are taking part-time, extension, or correspondence courses, or participating in adult education programs in fields of their choice, or receiving in-plant or on-the-job training. Fig. 2 gives the enrollment

in the primary-secondary schools of the Soviet Union in the fall, 1956. Table 2 indicates the breakdown by grade of the enrollment for the same period. Fig. 3 indicates the flow of students, per cents and numbers for the same period, 1955-1956.

The types of education and training offered are grouped into the following types: preschool education, general primary-secondary education, vocational education, semiprofessional and professional training, higher education, and postgraduate and advanced degree training.

Preschool education is divided into two levels: the nurseries or creches, for children from six weeks to three years of age; and the kindergartens for children from three to seven years of age. Each phase includes part-time, summer, and seasonal programs at playgrounds, resorts, and camps in addition to programs in the permanent year-round institutions. The USSR is a nation of working mothers and since the State requires a large number of women in the factory and farm work, preschool programs have become an integral part of the national economy. An unusual amount of attention is focused on this level of the Soviet educational system. Nurseries are regarded as preschool establishments and their major function is to render child-care service. The kindergartens, while providing this service, also carry on educational activities.

General primary-secondary education in the USSR consists of a ten-year coeducational program of studies for youth between seven and seventeen or eighteen years of age. It is compulsory through Grades VII and available through Grade X in cities and industrial centers. By 1960, the Soviets hope to have the ten-year program available throughout the USSR. When the fifth five-year plan was announced in 1951, it contained the goal of

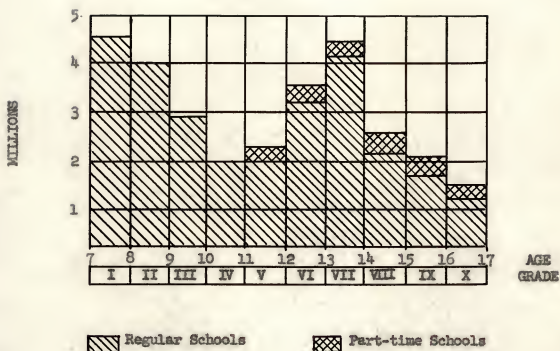


Fig. 2.--Enrollment in the Primary-Secondary Schools in the Soviet Union, Fall 1956.

TABLE 2
ENROLLMENT IN THE PRIMARY-SECONDARY SCHOOLS
IN THE SOVIET UNION, FALL 1955-1956

Regular Secondary Schools (Millions)

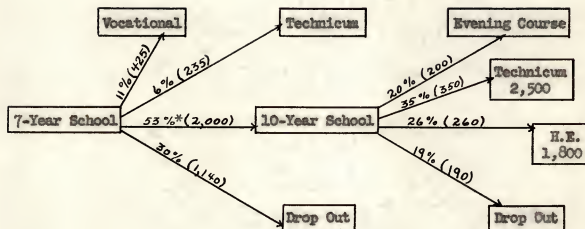
<u>Grades</u>	<u>Enrollment</u>	<u>Type of School</u>	<u>%</u>	<u>Enrollment</u>
I-IV	13.6 ¹	4 Yr. Schools	13	3.6
V-VII	9.3 ¹	7 Yr. "	33	9.4
VIII-X	5.25	10 Yr. "	54	15.1
Total	28.15 million	Special "	¹	.05
				28.15

Part Time (Thousands)

<u>Grades</u>	<u>Enrollment</u>	<u>By Grade¹</u>	<u>Enrollment</u>
I-IV	(less than 100)	V	200 ¹
V-VII	900	VI	300
VIII-X	900	VII	400
Total	1,800 ¹	VIII	350
		IX	300
		X	250
			1,800 ¹

Per Cent

<u>Grade</u>	<u>Regular School</u>	<u>Part-Time</u>
I-IV	99 ¹	¹
V-VII	91	9
VIII-X	85	15
I-X	94	6



There were an estimated 1,000,000 graduates from the 10th Grade in 1955-56.

Fig. 3.--Enrollment and Distribution Data (in thousands) 1955-56

*53% of all 7th Grade graduates went into the 8th Grade. This includes those in 7-year and 10-year schools.

compulsory ten-year education for urban children by 1955 and for rural by 1960. The experience of Soviet educators during the years 1952-55, altered this decision. Too many children were found unable to cope satisfactorily with the curriculum in Grades VIII through X.

Recent innovations in the Soviet secondary school program mark a phase in the Soviet struggle to attain quantitative secondary education. Between 1951 and 1955 a fourfold increase was announced in the number of pupils graduating from Soviet ten-year schools. With the expansion of the secondary school system new problems necessitated a review of the functional effectiveness of the program. The primary function of the secondary school previously was to prepare a rather select group of people for higher education. A majority of the ten-year school graduates continued their studies in colleges and universities. By 1953, this function could no longer be the main one since only about 30 per cent of the graduates could be accommodated in Soviet higher educational institutions. The larger number of young people completing the ten-year schools is confronting the regime with the problem of making the best use of graduates who do not get into higher education. Ways have to be developed to train them for nonprofessional jobs. This adjustment is taking place concurrently with the introduction in the school program of polytechnical trainings. Thus the technicum becomes one of the most important parts of the Soviet educational system geared to train scientists, engineers, and technicians.

In the USSR where skilled and semiskilled manpower for factory, office, and farm has been in critical supply for many years and where industrialization and mechanization have intensified demand, vocational training

and retraining have been accorded considerable attention. The function of the training has been to enable men and women to acquire or improve their skills, knowledge, working habits, and attitudes to make them capable workers for the Communist cause. Vocational training takes the following forms: basic elementary vocational schools for industry (FZU schools for factory and plant training, labor reserve system), vocational technical schools, employer-operated schools and courses, on-the-job training in industry, vocational agricultural education, and programs for mechanization of agriculture.

Education vital to survival of Soviet society

In creating the technical-scientific base on which the development of the country depends, training of scientific man power and woman power for the use of the State is considered of major importance. The supply of professional personnel depends upon the ability of an educational system to adjust itself to the changing needs of a society and upon its ability to train a sufficient number of persons for a variety of specialized tasks. The Soviet educational system is one of the main sources providing the economy with a flow of specialized personnel. The Soviets have indicated their conviction that education is vital to the survival of their society by devoting a great deal of attention to the educational system at large, to specific programs of training, to various aspects of educational policy and practice. The close association of the educational policies and the economy of the Soviet Union is indicated by: (a) the policy of involuntary placement of graduates in jobs which coincide with their field of formal training and their occupational specialties, (b) labor legislation restricting the individuals opportunity to change

jobs and occupations at will, and (c) the offering of a variety of incentives which encourage the individual to retain his professional occupation in the same field in which he received his formal training.

Summary and trends

Millions of children of school age, variety of racial strains and cultural traditions, diversity in climate and topography, concentrated centers of population, and sparsely populated remote areas are some of the factors affecting educational policy in the USSR. The principle of free and universal education has been adopted as a national policy and is in process of implementation in the Soviet Union today. Authoritarianism characterizes the Soviet philosophical base. The goal of education is to meet the needs of the State. This country does not have a national ministry to control education. In the USSR the Communist Party, consisting of about 3 per cent of the total population, is the minority group which directly and indirectly controls education through a mechanism which centralizes power at the top. The central committee of the Party periodically issues guiding directives outlining the aims, means, scopes, and limitations.

The key to an understanding of Soviet educational policy lies in an appreciation of its realistic approach toward training personnel for an economy based on rapid industrialization, and the consequent necessity for various types of trained manpower, scientists, engineers, supporting scientific and technological personnel, and skilled and semiskilled labor. Because the facilities for advanced training have been at a premium and are still insufficient to meet the demands of the country, selectivity has played an important part in Soviet education.

General primary-secondary education consists of a prescribed ten-year, six-day-a-week program of studies subordinated to the interests of the regime in the formation of a Communist society. Semiprofessional schools and technicums in the USSR are responsible for preparing students to render a single specific report service to persons considered qualified in a professional field. Advancement from semiprofessional to professional status is unlikely in the USSR. Large numbers of ten-year school graduates have begun to enter secondary semiprofessional training institutions, which now offer shorter training programs to accommodate them. Vocational education in the USSR usually is terminal training for a specific job or type of work needed by the State. The Party-State aims to determine, through its national planning mechanism, the skills which are needed and the proportion of the student population to be trained in each skill.

These recent developments, the spectacular increase in upper-grade enrollment, the substantial number of tenth grade graduates to provide for a wide selection of candidates for higher education, the channeling of surplus of secondary school graduates into semiprofessional or certain other newly created forms of vocational training, add up to a trend which should be strongly emphasized. The Soviets are beginning to realize the ambitious goals set twenty-five years ago, when it was originally conceived that the primary and secondary schools should provide general education to such an abundantly large number of young people that there would be no difficulty in selecting available talent for specialized training on the higher steps of the educational ladder. The realization of this goal undoubtedly opens a new potential for the further expansion of specialized professional and semiprofessional education.

A summary of other trends in education include the following:

- (1) the educational system, including an increased emphasis on mathematics as a basis for an expansion of science and engineering, is expanding rapidly and promises a raising of the average educational level; (2) ten-year compulsory education is anticipated by 1960 and is now in effect in the larger cities. Although in 1955-1956 only 53 per cent of those leaving the seven-year school went on to the upper three Grades VIII to X, it is believed that the new compulsory law will increase significantly this per cent; (3) the subordination of education to the economic system has become deeply entrenched and thus education remains the servant of production. From the standpoint of the individual, education is the key to occupational placement; (4) equal rights are granted both sexes; (5) coeducation in the middle school is the approved system.

And thus mathematics education in the USSR finds itself against a backdrop of many languages, a variety of cultures and interests, a highly centralized, Party controlled educational program, and an emphasis on mathematics education, seldom equalled at any place or at any time, directed to increase the scientific personnel. Having faith in "with knowledge goes power" the Soviets have devoted their efforts to the training of scientifically, technically trained people. They are making an all-out effort to develop an educational system to accomplish this goal. By funneling the less competent students into the Vocational Schools and Technicums a differentiated curriculum is provided to meet different abilities of the students. Thus, by such direction of students a type of homogeneous grouping is accomplished (Fig. 1). What the mathematics curriculum will look like under such conditions will be the next consideration.

Chapter III

THE MATHEMATICS CURRICULUM

Universal curriculum

In the Soviet Union the curricula and the scope of instruction are uniform in character. This, of course, does not mean to imply that the educational standards are uniformly upheld or enforced with equal rigidity in the various localities. There are, undoubtedly, some regional differences as to standards of instruction, but this has to be considered a problem of implementation rather than the lack of uniformity of curricula. Uniformity of curricula is one of the distinctive features of Soviet education on all levels of the ten-year school.

One of the fundamental criteria in the assessment of primary and secondary education is the instruction curriculum. The ministries of education implement decisions of the USSR Council of Ministers and the Communist Party through detailed curriculum instructions. Each course has its syllabus outlining the material to be covered and the reading assignments to be completed. There is no choice of subjects. Standardized textbooks and examinations are utilized to insure that each Soviet child will cover the same subject matter at a given level. Regional variations exist primarily in the teaching of language skills and in vocational orientation. The emphasis on science is universal and uniform in the Soviet school system.

Textbooks

The production of Soviet textbooks is a monopoly. Books to be used in the schools are prepared, reviewed, published, and revised under State auspices to insure that they include no more and no less than the prescribed basic information for each subject and that they present it from the approved point of view. A textbook for the Soviet schools must include a currently correct ideological interpretation of material and conform completely with the school syllabus. There are some subjects, such as mathematics, where the free application of ideological bias is limited. Arithmetic, algebra, trigonometry, and geometry--these remain the same whether politically biased phraseology is used or not. In these subjects the student must master basic principles and be able to apply them in the solution of problems whether the problem is stated in verbalisms glorifying the Soviet State or is stated contemptuously in words depicting Capitalists' conditions.

Textbooks must reflect the latest thinking and knowledge and be suited to the age of the school children. Each idea and concept in a textbook must be clear and be presented in a form pupils can understand.¹ Soviet textbooks also must be inexpensive because students must purchase their own books.

Soviet authorities recognize textbooks as a powerful instrument for forming the Marxist-Leninist world outlook. Requirements placed on authors are formidable. Although textbook authors are well paid and benefit from prestige and honor, authorities continue to have difficulty

¹Pravda, July 6, 1953.

in attracting the number of authors required, in securing sufficient copies of approved texts, and in achieving the quality educators consider essential.¹ Over the last twenty-five years about one billion copies of textbooks have been printed. While the supply of texts has been adequate, many are reprints of books the content of which has remained unaltered for almost two decades. This is especially true of mathematics texts which have not been withdrawn for revisions or modifications. Many Soviet textbooks are detailed and some tend to be brought up-to-date through revision rather than replacement.

Teachers are free to provide supplementary information from additional officially approved publications. (A problem facing the American teacher, that of seeking to insure that students have a chance to study all sides of a controversial issue, does not face the Soviet teacher. Supplementary learning materials in the USSR are State-sponsored and State-approved.)

Complaints about textbooks are frequently encountered in the Soviet press.² Textbooks often do not arrive on time at the beginning of the school year. The printing and illustrations are often badly done and the books often contain errors. Insufficient copies are printed of some textbooks while others are improperly distributed. Perhaps the most serious complaint is that textbooks simply do not exist for many subjects such as pedagogy and methods of teaching.³

¹Ibid.

²Teachers Gazette, January 6, 1954.

³Pravda, January 4, 1953.

Courses: content, time required

(Almost half of the primary-secondary curriculum is made up of courses in the physical and natural sciences, mathematics through trigonometry and mechanical drawing, because Soviet leaders believe that these subjects contribute most directly to mastery and control of the material environment.) By the time a student completes ten years of training, usually at the age of seventeen or eighteen, he has been introduced to the basic disciplines of literature, history, geography, physics, chemistry, mathematics, and biology. He is expected to have a good foundation of general information and to know fairly well where his particular abilities lie. The curriculum of the ten-year school for the last twenty years required the devotion of about 40 per cent of the total school hours to the study of the sciences (including mathematics), 6 per cent to physical education, and 54 per cent to the social studies and humanities. In the fall of 1955, however, it was announced that more time would be devoted to teaching physics, chemistry, and biology by reducing the study of humanities to secondary importance.

The emphasis on science in Soviet schools contrasts sharply with the situation in the United States. A careful look at Tables 3 to 6 will verify this point. Whereas the Soviet students graduating from the regular secondary school have taken courses in physics for five years, astronomy for one year, chemistry for four years, biology for five years, and mathematics including arithmetic, algebra, geometry, and trigonometry for ten years, less than a third of the American high school graduates

have taken a year of chemistry, about a fourth have had a year of physics, and less than a seventh have taken advanced mathematics.¹

Table 3 gives the formal hours required under the curriculum for Grades I - IV in Soviet schools. Table 4 depicts the curriculum required in Grades V - VII. Table 5 indicates the hours of instruction per week for Grades I - X in mathematics subjects. Table 6 outlines the curriculum of Grades VIII - X. Table 7 shows the time allocated in the curriculum to the required subjects.

Certain mathematical skills are expected of the child before he leaves kindergarten. He should be able to count up to twenty or thirty, recognize and compare figures, add and subtract numbers of one digit, use simple units of measurement such as the kilometer, meter and liter, and tell time by the clock at least in terms of hours.² In Grades I - IV the arithmetic syllabus covers addition, subtraction, multiplication, and division of whole numbers; the metric system and measures of time; addition and subtraction of fractions; and elementary ^{measurements} mensuration. Pupils are expected to apply their knowledge and solve simple problems involving whole numbers and fractions. The arithmetic cycle is completed in Grade V, which includes fractions, decimals, percentages, and proportions.

¹Washington Evening Star, December 6, 1957, In a recent speech before the Southern Association of colleges and Secondary Schools the United States Commissioner of Education, Lawrence G. Derthick, indicated that 100,000 of the 1.2 million high school graduates last year had no opportunity to study advanced mathematics during their last two years of school. He indicated other facts concerning United States education, namely, the per cent of the United States public high schools that did not offer chemistry in the fall of 1957; the per cent that did not offer physics, plane geometry, nor intermediate algebra; the per cent of the twelfth grade students that were enrolled in public high schools that offered neither trigonometry nor solid geometry.

²Medynskii, op. cit., pp. 49-50.

TABLE 3

CURRICULUM FOR GRADES I - IV IN RUSSIAN-SPEAKING SCHOOLS: 1955-1956¹

Subject	Class I		Class II		Class III		Class IV		Total
	Hours per week	Hours per year	Hours per week	Hours per year	Hours per week	Hours per year	Hours per week	Hours per year	Hours per subject
1	2	3	4	5	6	7	8	9	10
Russian grammar, reading, and writing	13	429	13	429	13	429	9	297	1,584
Arithmetic	6	198	6	198	6	198	6	198	792
Drawing	1	33	1	33	1	33	1	33	132
Singing	1	33	1	33	1	33	1	33	132
Physical education	2	66	2	66	2	66	2	66	264
Practical work	1	33	1	33	1	33	1	33	132
History	--	--	--	--	--	--	2	66	66
Geography	--	--	--	--	--	--	2	66	66
Biology	--	--	--	--	--	--	2	66	66
TOTAL	24	792	24	792	24	792	26	858	3,234

¹Medynskii, op. cit., p. 84.

TABLE 4

CURRICULUM FOR GRADES V - VIII IN RUSSIAN-SPEAKING SCHOOLS:

1955-1956¹

Subject	Class V		Class VI		Class VII		Total hours per sub- ject
	Hours per week	Hours per year	Hours per week	Hours per year	Hours per week	Hours per year	
1	2	3	4	5	6	7	8
Russian language and literary reading	9	297	8	264	6	198	759
Mathematics	6	198	6	198	6	198	594
History	2	66	2	66	2	66	198
Geography	3	99	2	66	2	66	231
Biology	2	66	2	66	3	99	231
Physics	--	--	2	66	3	99	165
Chemistry	--	--	--	--	2	66	66
Foreign language	4	132	4	132	3	99	363
Physical education	2	66	2	66	2	66	198
Technical drawing	--	--	--	--	1	33	33
Practical work in shop and agriculture	2	66	2	66	2	66	198
Drawing	1	33	1	33	--	--	66
Singing	1	33	1	33	--	--	66
TOTAL	32	1,056	32	1,056	32	1,056	3,168

¹Ibid.

TABLE 5

MATHEMATICS CURRICULUM BREAKDOWN

Subject/Grade	I	II	III	IV	V	VI	VII	VIII	IX	X
Arithmetic	6*	6	6	6	6	2				
Algebra						2	3	3	2	2
Geometry						2	3	3	2	2
Trigonometry									2	2

*Arabic numerals refer to hours of instruction per week

TABLE 6
CURRICULUM FOR GRADES VIII - X IN RUSSIAN-SPEAKING SCHOOLS:
1955-1956¹

Subject	Class VIII		Class IX		Class X		Total hours per sub- ject ^a
	Hours per week	Hours per year ^a	Hours per week	Hours per year ^a	Hours per week	Hours per year ^a	
1	2	3	4	5	6	7	8
Literature	6 ^b	181.5	4	132	4	132	445.5
Mathematics	6	198	6	198	6	198	594
History	4	132	4	132	4	132	396
Geography	2 ^b	82.5	3	99	--	--	181.5
Biology	2	66	1	33	--	--	99
Physics	3	99	4	132	5 ^b	148.5	379.5
Chemistry	2	66	3	99	3 ^b	115.5	280.5
Foreign language	3	99	3	99	3	99	297
Physical education	2	66	2	66	2	66	198
Technical drawing	1	33	1	33	1	33	99
Practicum in agriculture machine construction and electrotechnology	2	66	2	66	2	66	198
Constitution of the USSR	--	--	--	--	1	33	33
Astronomy	--	--	--	--	1	33	33
Psychology	--	--	--	--	1	33	33
TOTAL	33	1,089	33	1,089	33	1,089	3,267

¹Ibid.^aComputed.^bIndicates a change in the number of hours for the second semester.

Slide rules and calculating machines are introduced at this time.

Algebra and geometry begin in Grade VI, continue to Grade VII, and are studied in some detail in subsequent grades. Arithmetical calculations are made from time to time as review work. Mathematics courses continue with the separate subjects, algebra, geometry, and trigonometry through Grade X. Coverage in these subjects coincides closely with the entrance requirements for higher educational establishments. Throughout the three-year (VIII - X) course emphasis is placed on the application of theory in the solution of problems in such related subjects as physics and astronomy and on solving problems in agricultural technology. Students are required to complete a number of practical problems such as surveying lots, determining distances, and making blue prints.)

The material covered in Algebra, Part I, taught in Grades VI and VII, consists of: algebraic expressions, equations; rational numbers; operations with complete algebraic expressions; separation of polynomials by factors; algebraic fractions; first degree equations with one unknown; equations with two unknowns; and systems of first degree equations.¹

The material covered in Algebra, Part II, taught in Grades VIII - X, consists of: identical transformations with powers and roots; functions and their graphs; quadratic functions; inequalities; progressions; generalization of ideas concerning exponents; logarithms; analysis of equations; imaginary and complex numbers; some information concerning algebraic equations; indeterminate equations; combinations and Newtonian binomials.²

¹A. N. Barsukov, Algebra, Part I. Algebra textbook for sixth and seventh grades of the Secondary School, 1956. See appendix C.

²A. P. Kiselev, Algebra, Part II. Algebra textbook for VIII - X Grades of the Secondary School, 1956. See appendix C.

TABLE 7

PER CENT OF TIME ALLOTTED TO SUBJECTS REQUIRED FOR GRADUATION
FROM SOVIET TEN-YEAR PRIMARY-SECONDARY SCHOOLS: 1955-1956

Subject	Per Cent of Time
Humanities- - - - -	46.9
Mathematics - - - - -	20.1
Biology - - - - -	4.0
Physics - - - - -	5.6
Astronomy - - - - -	.3
Chemistry - - - - -	3.5
Others- - - - -	8.9
TOTAL for Mathematics and Sciences- - - - -	42.4
Physical, military, drawing and singing - - - - -	10.7
TOTAL - - - - -	100.0

The material covered in plane geometry, taught in Grades VI and VII, consists of: proportionate segments; similarity of figures [*forms*]; metric relationships in a triangle and in a circle; rectilinear polygons and calculation of the circumference; measurement of areas.¹

The material covered in solid geometry, taught in Grades VIII - X, consists of: straight line and plane; dihedral angles, perpendicular surface and polyhedral angles; polyhedrals; circular bodies.²

The material covered in trigonometry, taught in Grades IX and X, consists of: trigonometric functions, direct and inverse; identities and conditional equations; tables and graphs.³

(Calculus as a formal subject is not taught in the secondary schools. Some of the mathematics clubs study it as one of their projects.)

¹P. P. Andreyev, Elementary Geometry Course for Technicians, 1957. See appendix C.

²Ibid.

³S. Kownacki, "Comparative Study of Soviet Preuniversity Instruction in Mathematics and Physical Science" (unpublished, incomplete draft, 1954).

Only the major topic headings are listed in Table 8.¹ Except for arithmetic in Grades V and VI and algebra in Grade VI, the 1955-1956 syllabus is identical with the 1952-1953 syllabus.² Homework hours by topics are the officially assumed average listed in the syllabus as a guide in assigning home study.

TABLE 8

A SUMMARY OF THE SOVIET SECONDARY SCHOOL MATHEMATICS SYLLABUS
FOR THE 1955-1956 SCHOOL YEAR GRADES V THROUGH X

Grade V (age 11-12). Mathematics: 6 hr/wk

<u>Arithmetic (6 hr/wk)</u>	<u>Class Hours</u>	<u>Homework</u>
1. Whole numbers	20	8
2. Divisibility of numbers	20	8
3. Common fractions	90	36
4. Decimal fractions	50	20
5. Practical studies	6	--
6. Review	12	6
TOTAL	198	78

Grade VI (age 12-13). Mathematics: 6 hr/wk

<u>Arithmetic (2 hr/wk)</u>		
1. Percentage ³	20	10
2. Proportions. Direct and inverse proportionality	32	16
3. Review	14	7
TOTAL	66	33

¹Programmy srednei shkoly na 1955-1956 uchebnyi god. Matematika (Syllabi for the Secondary Schools, 1955-1956 School Year. Mathematics) Moscow: Uchpedgiz 1955, CENIS Translation Series 56-2.

²1952-1953 Soviet Syllabus in Mathematics, CENIS Translation Series 56-1.

³Prior to 1956 percentage was taught in Grade V.

TABLE 8--Continued

<u>Algebra (2 hr/wk)</u>		<u>Class Hours</u>	<u>Homework</u>
1.	Algebraic expressions. Equations	15	8
2.	Positive and negative numbers	20	10
3.	Operations with whole algebraic expressions	31	16
	TOTAL	66	34
<u>Geometry (2 hr/wk)</u>			
1.	Introduction	10	5
2.	Triangles	30	15
3.	Parallel straight lines	26	13
	TOTAL	66	33

Grade VII (age 13-14). Mathematics: 6 hr/wk

<u>Algebra (4 hr/wk, 1st semester;</u>			
<u>3 hr/wk, 2nd semester)</u>			
1.	Algebraic fractions	24	12
2.	Proportions and proportionality	6	4
3.	Linear equations with one unknown	30	15
4.	Systems of linear equations	18	9
5.	Extraction of square roots	12	6
	TOTAL	90	46

<u>Geometry (2 hr/wk, 1st semester;</u>			
<u>3 hr/wk, 2nd semester)</u>			
1.	Quadrangles	26	13
2.	Circumference	32	16
3.	Inscribed and circumscribed triangles and quadrangles	16	8
	Review (arithmetic, algebra, and geometry)		
	TOTAL	74	37

Grade VIII (age 14-15). Mathematics: 6 hr/wk

<u>Algebra (4 hr/wk, 1st semester;</u>			
<u>3 hr/wk, 2nd semester)</u>			
1.	Powers and roots	30	15
2.	Quadratic equations and equations of higher powers reducible to quadratics	42	21
3.	Functions and their graphs	10	5
4.	System of 2nd degree equations with two unknowns	18	9
	TOTAL	100	50

TABLE 8--Continued

<u>Geometry (2 hr/wk, 1st semester; 3 hr/wk, 2nd semester)</u>		<u>Class Hours</u>	<u>Homework</u>
1.	Similar figures	30	15
2.	Trigonometric functions of an acute angle	12	6
3.	Metric relationships in a triangle and a circle	24	12
4.	Areas of polygons	14	7
	TOTAL	80	40
	Review	18	

Grade IX (age 15-16). Mathematics: 6 hr/wk

<u>Algebra (2 hr/wk)</u>			
1.	Numerical sequences	19	10
2.	Generalization of the concept of exponents	8	4
3.	Exponential functions and logarithms	36	18
	TOTAL	63	32

<u>Geometry (2 hr/wk, first 3 quarters; 3 hr/wk, last quarter)</u>			
1.	Regular polygons	12	6
2.	Length of circumference and area of a circle	10	5
3.	Straight lines and planes	43	22
	TOTAL	65	33

<u>Trigonometry (2 hr/wk, first 3 quarters; 1 hr/wk, last quarter)</u>			
	TOTAL	56	28
	Review	14	

Grade X (age 16-17). Mathematics: 6 hr/wk

<u>Algebra (2 hr/wk)</u>			
1.	Combinations and the binomial theorem	12	6
2.	Complex numbers	12	6
3.	Inequalities	22	11
4.	Equations of higher powers	12	6
	TOTAL	58	29

<u>Geometry (2 hr/wk, 1st semester; 1 hr/wk, 2nd semester)</u>			
1.	Polyhedrons	28	14
2.	Solids of revolution	20	10
	TOTAL	48	24

TABLE 8--Continued

<u>Trigonometry (2 hr/wk, 1st semester; 3 hr/wk, 2nd semester)</u>	<u>Class Hours</u>	<u>Homework</u>
1. Solution of oblique-angled triangles	18	9
2. Inverse trigonometric functions	14	7
3. Trigonometric equations	16	8
4. Review and problem solution	16	8
TOTAL	64	32
Review	28	

Recapitulation

Mathematics in the last six grades of the Soviet ten-year school of general education (Grades V - X, age eleven through seventeen).

<u>Subject</u>		
1. Arithmetic	274	111
2. Algebra	389	191
3. Geometry	363	167
4. Trigonometry	162	60
TOTAL, Grades V - X	1,188	529

Equipment of classrooms

The majority of Soviet children attend school on a shift basis due to the lack of classroom space. The number of pupils is increasing at a considerably faster rate than school buildings can be erected to house them.¹ The schools operate in three shifts from eight in the morning until eight in the evening. Having adequate equipment for such crowded conditions is impossible.

Though some Soviet schools are reasonably well supplied with equipment, other localities report serious shortages of even the most common essentials.² Even some of those schools nearest the capital and in the

¹Pravda, April 6, 1954.

²Teacher's Gazette, April 8, 1953.

larger Soviet cities have not had the simplest kind of accessories, triangles, rulers, blackboards, and devices to learn arithmetic. Even some of the new schools that had been constructed contained similar shortages.¹ However, laboratory facilities in Soviet schools have, from all available reports, improved considerably in both quality and quantity of equipment in the last few years. Insufficient staff, buildings, and equipment in outlying areas have led to abnormal concentration of educational institutions in highly populated centers in European Russia.

Most Soviet schools have a patron which helps the school acquire special facilities. In urban areas the patron may be a factory or a local trade union branch. A neighboring theater or an army or a navy unit may fill this role. In any event, patrons provide schools with equipment for work shops, perhaps some photographic equipment, or books. Limitations are not put on the type or amount of help which a school may receive through this medium, provided the help is consistent with the political and ideological concepts.

The technicums run by the great industrial ministries of the nation seemingly are better equipped than the public schools.² In a particular technicum in Kiev, maintained by the Ministry of Coal and Coke, the equipment models and laboratories were reported to be more than adequate. Some of the equipment covering rooms one hundred feet long was worth millions of rubles.³

¹Ibid, January 6, 1954.

²William Benton, Voice of the Kremlin (Reprint of the 1956 Book of the Year, Encyclopedia Britannica).

³Ibid (Reported by interviewed principal of the school), p. 8.

Curriculum flexibility

(Classes are conducted in the native tongue. The same basic curriculum is taught and the same subject matter is required, whether the children are taught in Ukrainian, Tadzhik, Estonian. There is no choice of electives. High concentration on science instruction is a distinctive feature of Soviet secondary education.)

Examinations

Soviet education authorities feel they have a fairly effective method of assessing a student. Daily work is evaluated through homework assignments, oral recitations in class, and periodic tests. (Marks are entered in a record book for each pupil which he keeps with him and which is signed by the child's parents each week.) The marks range from 5 (excellent) to 1 (failure). In order to pass, a pupil's marks must average a 3 in each subject. Pupils who receive a 2 in one or even two subjects may take repeat examinations in the fall after completing a summer reviewing session. Those who receive more than two unsatisfactory marks or who fail a subject are required to repeat the grade.

Prior to the school year 1956-1957, promotion from all but the first three grades was based on the passing of the following examinations: Grade IV, Russian language, and arithmetic (written and oral); Grade V, Russian language (written), and arithmetic (oral); Grade VI, Russian language and arithmetic (written), botany (oral); Grade VII, Russian language and algebra (written), Russian literature and geography (oral); Grade VIII, literature and algebra (written), geometry (oral); Grade IX, literature and algebra (written), modern history, geometry, and foreign

language (oral); Grade X, Russian language (written composition), geometry and trigonometry (written), literature, algebra, physics, chemistry, and history of the USSR (oral). In schools where the language of instruction is not Russian, final examinations are required in native language and literature.

Beginning with the school year 1956-1957, promotion from all grades except IV, VII, and X is based on the pupil's cumulative record of daily work, homework assignments, periodic quizzes and tests, and quarterly subject examinations. Promotion from the three grades, IV, VII, and X, is based on final standardized examinations in addition to the cumulative record. These are State examinations which are centrally prepared and distributed through the Republic Ministries of Education to the schools in the USSR. They relate to what Soviet pupils are expected to know. It is significant to note that only 53 per cent of the seven-year graduates go on into the regular secondary school. State inspectors verify the administration of the examination and the republic education authorities evaluate the results. In this fashion the State aims to maintain a check on the attainment standards of individual, district, and republic schools.

Written tests are conducted in much the same fashion as in the United States. Each oral examination is conducted by a panel consisting of the subject teacher, the teacher of the same subject at another school or the Deputy Director for Instruction, and the school director. About half the class sits for the oral examination at the same time. Pupils are called before the panel one by one. Each draws a ticket and is allowed about fifteen minutes to think through his answers to the two or possibly three questions printed on the ticket. He is given approximately ten minutes in which to make his replies.

At the end of their tenth year of primary-secondary schooling, Soviet boys and girls who have received grades of 3 (passing) or better for each subject in the tenth grade, and no less than 5 (excellent) in behavior, are eligible to sit for the State matriculation examinations covering the work of the tenth grade and essential topics studied in previous grades.¹ Also those over seventeen years of age who through study on their own or in a part-time program have prepared to take them, may do so.² Those who successfully pass these month-long comprehensive examinations are awarded a matriculation certificate (somewhat equivalent to the United States high school diploma), a prerequisite to study in programs at the next higher level.

The function of the matriculation examination is reported to be to insure that the graduates of the ten-year school are: (1) masters of the information believed essential for Soviet citizens; (2) able to relate theory to its practical application in society; (3) displaying the Communist attitude in their interpretations, judgments, and analysis of questions and problems presented. Decrees on education state that graduates must demonstrate a knowledge of mathematical laws and rules, an understanding of the logical connection between them, an ability to prove theorems and apply them in the solution of practical problems, and an ability to solve problems of any sort studied in secondary school.

¹A. M. Danev, Narodnoe Obrazovanie (Resolution of the Council of People's Commissars of the RSFSR, No. 508, June 19, 1944), pp. 111-114.

²Danev, Instructions Issued by the Ministry of Education of the RSFSR, October 30, 1946, pp. 114-124.

The following basic subjects have been made obligatory for matriculation examinations: plane and solid geometry (written), trigonometry (written), algebra (oral, with a problem to be solved), physics (oral, with a laboratory problem), and chemistry (oral, with a laboratory problem). Some weeks before the matriculation examination a pamphlet outlining the general subjects on which oral examinations and questions will be asked throughout the USSR is prepared and issued by the RSFSR Ministry of Education. Ten days before the examinations teachers formulate their questions and write them on cards known as *bileties*.* There are usually three questions per card. In algebra one question is a problem or an equation to be worked out on the blackboard, while for physics and chemistry one of the three problems requires the examinees to perform a laboratory experiment and to make any necessary mathematical-related calculations. While pupils are permitted to see the general topics for the oral examinations ahead of time, they do not know what specific questions will be asked nor precisely what problems in mathematics they will have to solve.

The written examinations, centrally prepared, are not made available to school directors until one or two days before they are to be administered. Pupils do not see them until the examination begins. During the period before examinations, teachers go over material with the pupils stressing difficult or complicated aspects of each subject. A formal examination panel similar to those in the lower grades, evaluates the answers of each student. The panel includes the subject teacher, the school director (or in the larger schools the Deputy Director for

*See Appendix A.

Instruction), a teacher of the same subject from another school or from another class, and possibly two or three representatives from the Ministry of Education of the republic concerned and the local education authority. Since 1955, however, neither official representation has been obligatory.

Pupils who fail to pass matriculation examinations or who are not permitted to take them because of medical excuse or inadequate school records, are not kept back for a second year but are issued a certificate indicating average marks received in the subjects studied. They are given the right to take their matriculation examinations in the same school the following year.

Each year between 2 and 5 per cent of the tenth grade graduates receive honors with gold and silver medals. Gold medals are awarded to those who pass each subject on which they were examined with a grade of 5, receive 5's in the other secondary school subjects, and have excellent behavior. A silver medal goes to those whose behavior is excellent and who have passed with 5's all subjects covered by the matriculation examination, but who have received not more than three marks of 4 in other subjects, such as physical education and mechanical drawing.

Entrance examinations into Soviet higher educational establishments are mentioned here only because it is felt that they have an influence on the training and examination content of those Grades V through X. The material covered for each subject in the entrance examination is based on that given in the Soviet ten-year school, particularly the material taught in Grades V through X.¹ While the set of subjects on entrance

¹B. I. Gorokhoff, Materials for the Study of Soviet Specialized Education (National Academy of Science, NRC, Office of Scientific Personnel, Washington, D. C., 1952).

examinations may vary from one institution or one field of future study to another, the material covered in each subject is, theoretically, uniformly determined on the basis of the secondary school curriculum.* The Soviet press often voices the complaint that there is some disparity between the coverage of a given subject on the entrance examination and the material covered in the same subject in the secondary school.

In conformity with a decree¹ of the USSR and Russian Republic Councils of Ministers, the Russian Republic Ministry of Education has issued a decree: "On Reducing the Number of Examinations in Schools." With a view to eliminating overloading the pupils with studies, starting in the 1953-1954 school year the number of promotion and final examinations and matriculation examinations in schools was to have been drastically reduced. In the fourth and fifth grades two examinations (in Russian and arithmetic) were to have been given instead of four; in the sixth grade three examinations (in Russian, arithmetic, and botany) were to have been given instead of five; in the seventh grade four (in Russian, written and oral, and in algebra and geography) instead of eight; in the eighth grade three (in literature, algebra, and geometry) instead of six; and in the ninth grade five (in literature, modern history, algebra, geometry, and a foreign language) instead of the eight examinations formerly given. Pupils completing secondary school studies were to have been given not nine examinations, as heretofore, but seven--Russian language and literature

*See Appendix B--Collections of mathematical problems presented on entrance examinations.

¹Pravda, April 21, 1953, p. 3.

(written), literature (oral), geometry and trigonometry (written), algebra, physics, chemistry and USSR history. In the Russian language examination given in Grade VII the third group of questions of readings in literature and arithmetic problems from the algebra and arithmetic examinations were to have been excluded from the test.

Because of the reduction in the heavy volume of the curriculum, it now appears feasible to shift the responsibility for making up examinations for the fifth, sixth, eighth, and ninth (nongraduating) grades from the ministries of education to the teachers. When this shift was first announced in January 1955, only oral examinations seemed to have been affected. Close supervision from the top exercised through the examinations to insure the study of the entire curriculum apparently is no longer considered necessary. Although the Republic Ministries of Education continue to make up the examinations for the fourth, seventh, and tenth grades, they have abandoned an important measure of control they have hitherto maintained over the accuracy of the grading of the tenth grade examinations. Controls will, however, be maintained over medalists, since their written examination papers must be sent to the Oblast sections or to the Republic Ministries of Education for confirmation.

New rules have also been put into effect making easier exemption from examination of all pupils who, because of nervous excitement are overfatigued, might suffer harm if they attempted to take them. This change tends to confirm reports that prior to the reduction in the number of examinations many pupils became ill while taking them because they were so rigorous and drawn out.

Summary

The mathematics curricula throughout the USSR has one dominating characteristic, namely, uniformity. This is a significant distinctive feature of Soviet education on all levels of the secondary school. Each mathematics course has its syllabus, giving the material to be covered and homework assignments.

Mathematics textbooks are prepared, published, and revised under strict State supervision. This is done to provide only the selected basic information for each subject. In most cases the texts are reprints of books whose contents have remained the same for the last twenty years.* Many of the mathematics texts are brought up-to-date through revision rather than replacement. Mathematics teachers are free to provide any supplementary information from officially approved publications.

The child going from kindergarten to the first grade should be able to count up to twenty or thirty, add and subtract one-digit numbers, and use simple units of measure. The syllabus for Grades I - IV requires some two-hundred hours of instruction in arithmetic covering the fundamental operations on whole numbers and addition and subtraction of fractions. Multiplication and division of fractions, decimals, percentages, and proportions are considered in Grade V. Algebra, geometry, and trigonometry as separate subjects are offered in the later grades. Each student takes six hours of mathematics per week in each grade, I through X.** The studying of mathematics occupies more than 20 per cent of the total time required for graduation from the Soviet ten-year school.

*See Appendix C.

**See Table 5.

At the end of Grade X the matriculation examination is given. Mathematics teachers are very conscious of the importance of this final test. This examination covers topics such as plane and solid geometry, trigonometry, and algebra. The teacher has the task of preparing his students for this vital examination which is both oral and written.*

Approximately 12 per cent of all seventeen-year olds graduate from Grade X. With the curricula being uniform throughout the USSR this means that 12 per cent of all seventeen-year olds have had mathematics through trigonometry. Another influencing element on mathematics teachers is the entrance examination for Soviet higher educational establishments. Because of the limited facilities at this level, the selection of university freshmen is getting very strict and the competition is very high. Since the entrance examinations are heavily weighted towards mathematics, the teacher in this field feels the pressure.

Recent reorientation of the curriculum in the general schools will give greater emphasis to technical studies and practical training. The reduction in the school work, including a decrease in mathematics course content, homework, and final examinations is a new move announced in the sixth five-year plan.^{1,2} The next chapter will discuss the training of teachers of mathematics to meet this reorientation of the curriculum, and the new emphasis on science and technology.

*See Appendix B.

¹Pravda, November 26, 1957, p. 4.

²Izvestia, November 26, 1957, p. 6.

Chapter IV

THE TRAINING OF MATHEMATICS TEACHERS

General patterns of teacher education

Even though the Russian people traditionally have held in esteem the teacher and the scholar, respect for those in the teaching profession reached a low mark in the early years of the Soviet regime. The new government had to face apathy, noncooperativeness, and even strikes on the part of its teaching personnel. The teachers were suspected, distrusted, spied upon by students and superiors, and their authority in the school was nonexistent. The new teachers were ill-trained while the profession as a whole was underpaid, overworked at school, and required to take part in many Communist agitation and propaganda campaigns. With the introduction of the complex-project method of instruction, the professionally-trained teacher was almost completely eliminated.

This attitude of the Soviet regime slowly changed as the leaders came to realize that the interests of the State demanded educationally qualified teachers. The situation was frankly recognized in the directive of the central committee of the Communist Party of September 5, 1931 that

called for a systematic, serious program of teacher-training. As time went on teachers as individuals and the profession as a whole came to enjoy increasing respect, greater responsibility and authority, increased prestige, and social status. The Soviet press added to the prestige of the profession when it stated that the many changes which had occurred to Russia under the Soviet regime were in no small degree due to the unselfish labor of the Soviet teacher.¹

So rapid has been the expansion of education in the Soviet Union, that the supply of teachers has never been able to keep pace with the demand. However, the teacher shortage in the USSR, today, apparently is not as critical as in the United States. Difficulty in meeting the demand for teachers in an expanding school system has been multiplied by a curriculum organization which requires teachers to be trained in one of the following fields: mathematics, physics, chemistry, natural science, history, Russian language and literature, native languages and literature, foreign languages (English, French, or German), music, art, physical education, primary school teaching, and kindergarten teaching.

In 1955-56, a report showed 1,733,000 teachers as employed in Soviet primary and secondary schools with 1,655,000 as teachers in the regular schools and in institutions for the sick and handicapped children, and 78,000 as teachers in the evening and part-time schools for unemployed youth and adults.² Of this total in the teaching profession an estimated

¹Pravda, 10 Dec 1954.

²Anon, Narodnoe Khozyaistvo, SSSR, Statisticheskii Sbornik (The National Economy of the USSR, Statistical Handbook) (Moskva, 1956), pp. 222-223.

80 per cent are women although the per cent varies by grade level, more men teach in the senior secondary grades while more women teach in the primary grades.

TABLE 9

TOTAL NUMBER AND DISTRIBUTION OF ELEMENTARY, SEVEN-YEAR, AND
TEN-YEAR SCHOOL TEACHERS BY GRADES AND, IN PER CENT,
BY SEX AND TEACHING EXPERIENCE, 1955¹

Grades & Positions	Total Number (Thousands)	Per Cent		
		Women	Teaching Experience	
			To 5 Years	25 Years or more
Grades I - IV	446.7	86.5	18.3	10.1
Grades V - VII	556.8	74.4	29.3	6.9
Grades VIII - X	257.1	70.0	34.6	9.6

Administration of the teacher-training program

The republic ministries of education finance and maintain their own teacher-training establishments while general supervision of academic standards rests with the USSR Ministry of Higher Education. Over universities, the Ministry of Higher Education exercises full responsibility. In coordinating curriculum requirements, approving new staff appointments, setting admission quotas, and so on, ministries of education work primarily with the Ministry of Higher Education's Chief Directorate of Semiprofessional Training and its Directorate of Pedagogical Institutions. The Department

¹USSR, Kul'turnoye Stroitel'stvo, 1956, pp.178-179.

of Preschool Education in each Ministry of Education of the Union Republic has control over the training and appointment of all kindergarten teachers.

Certification

The type of diploma awarded a trained teacher in the USSR depends on the kind of program followed. Each diploma carries with it a corresponding certificate. Graduates of pedagogical schools or other schools of equivalent status receive the diploma of kindergarten school teacher or primary school teacher, depending upon the training received. Graduates of pedagogical institutes or universities receive a diploma of secondary school teacher of a specific subject in Grades V through X. Graduates of teacher institutes have the right to teach in Grades V to VII only.

Teacher-training Institutions

The training of teachers in the Soviet Union is concentrated in three types in institutions: (1) semiprofessional educational establishments known as Pedagogical Schools; (2) universities; and (3) higher educational institutions devoted to teacher-training called Pedagogical Institutes. The kindergarten and primary school teachers are trained in the pedagogical schools while the teachers for Grades V to X are trained in pedagogical institutes and universities. From 1921 until the middle 1950's Soviet pedagogical schools training teachers for work with younger children were open to graduates of the seven-year school. With the extension of ten-year education and beginning in September 1954, these training programs began to be reorganized into two-year courses at the junior college level for graduates of the ten-year school. By September 1956, the majority of

the pedagogical schools reportedly had been so reorganized and by 1960 all are expected to.¹ These are the schools that train the primary and kindergarten teachers.

As of January 1955 there were 206 resident and four correspondence schools of the category, pedagogical institutes. Prior to 1954 pedagogical institute and university graduates assigned to teach in secondary schools taught only in the upper Grades (VIII - X). Beginning with the 1955-1956 academic year, the recruitment of secondary school teachers for Grades V - X was from among those who had completed higher education. University graduates of certain specialties were assigned to teach in the secondary schools in increased numbers. Not fewer than 80 per cent of those graduating from the university departments of philology, history, geography, and biology and now fewer than 60 per cent of the graduates of the physics, mathematics, and chemistry departments were directed to teach in secondary schools. The total 1956 output of teachers was approximately: universities (five-year term) - 12,000; four-year pedagogical institute - 60,000; and two-year teachers institute - 30,000. This gave a total of 102,000 comprising somewhere near 6 per cent of the total number (1.73 million) of school teachers in the USSR.

Immediately following World War II the number of teachers trained reportedly increased rapidly as new pedagogical schools were opened. The increase in number of ten-year schools and in the size of the student body in Grades VIII to X during the early 1950's made it necessary to open more

¹Izvestia, July 10, 1954, p. 2.

institutes, to revise curricula, and to introduce more up-to-date textbooks in mathematics, physics, chemistry, and biology. The practice had been to train students to teach either of two related subjects such as physics and mathematics, or history and geography, to pupils in the upper grades only. However, in an educational situation in which the majority of children were enrolled in schools with all ten grades, Soviet educators found it more desirable to introduce curricula designed to train prospective teachers in a single subject field and then to prepare them to teach that subject at any grade level of the school. In the new curricula more time, also, was allotted to practice teaching and independent study. The types of schools in which Soviet teachers are trained today are given in Table 10.

In summarizing the significant trends that have taken place in the programs in the teacher-training institutions it must be pointed out that a relatively large per cent--80 per cent in some subjects to 60 per cent in others--of college graduates are trained and directed to teach. This is one of the very important aspects of the institutions of higher learning in Russia. Teacher-training, therefore, is a major function of these institutions.

Curriculum

Instruction in higher education institutions is based on curricula approved by the USSR Ministry of Higher Education. It is the Soviet practice to approve a single standard curriculum for each basic field and specialty, permitting variations only in the most advanced courses.

The curricula cover general lecture courses, seminars, laboratory work, special classes, and practical work. The required subjects and number of hours are identical for all higher schools in which the same majors are offered. Students are required to participate in all parts of the program scheduled in the approved curriculum for their field. In the first two and one-half to three years students in the same college follow an identical curriculum. In the last year in addition to required courses, students may take some optional courses.

TABLE 10
THE TYPES OF SCHOOLS IN WHICH SOVIET
TEACHERS ARE TRAINED

Type of School	- Length - of - Course	-	Grades for Which Students are Trained	- Schools from Which Students are Recruited
Pedagogical Secondary Schools	- 4 - Years - (2-Years)	-	Kindergarten Primary Classes aged (3 - 11)	- Seven-Year Sch - (Aged 14 plus) - (1960: Ten-Year)
Pedagogical Institutes	- 4* - Years -	-	Grades V - X (Children aged 11-17)	- Ten-Year School - (Aged 17 plus) -
Universities	- 5 - Years -	-	Grades V - X (Children aged 11-17)	- Ten-Year School - (Aged 17 plus) -
Teachers' Institutes	- 2 - Years -	-	Grades V - VII (Children aged 11-14)	- Ten-Year School - (Aged 17 plus) - (1960: Abolish)

*Now extended to 5 Years

Differences between pedagogical institutes and universities make it difficult to speak of the exact training program for Soviet secondary school teachers. Whether at a university or a pedagogical institute, the future teacher majors in the subject he is to be certified to teach in the secondary school and completes standard courses in the basic tenets of Communism, a foreign language, physical education, and specified courses in pedagogy and methods of teaching his specialty. A great deal of time is devoted to political indoctrination subjects, which are stressed much more heavily here than in other types of professional training. A foreign language, as well as science subjects such as elements of biology, chemistry, and physics are taught regardless of the teacher's future specialty.

A university student, compared to the institute student, who goes into teaching has had less instruction in basic education courses, more work in his subject field, and has completed a diploma thesis attesting to his familiarity with independent research techniques. Within a specialty, very long courses are given. For example, for mathematics teachers a course on the principles of elementary mathematics and the teaching methods thereof embraces about 400 instruction hours, which consumes about a quarter of the entire special field instruction time and is spread over a period of two years. These courses discuss at length how to use textbooks and what type of home assignments should be given in a certain topic.

During the third year of study, students are usually given two practice periods of about six weeks each, teaching their respective subjects in the secondary schools. Practice teaching is a basic requirement.

Some of it is scheduled in the pedagogical curricula and some is done during the summer vacation. During this work students are expected to become familiar with school organization, classroom teaching techniques, and other educational programs functioning in the country. Before beginning their practice teaching, students attend conferences in which each student conducts a lesson which the instructor analyzes. Then students observe classroom situations in the secondary school attached to the institute or in neighboring ten-year schools. Eventually they take over regular secondary class lectures and laboratory sessions. In addition, they acquire experience by teaching in the evening classes for adults and working with rural youth, and by acting as leaders of extra-curricular work in activities and clubs. Students in pedagogical institutes also spend three weeks of one of their eight-week summer vacations doing practice teaching in the Pioneer camps. Thus, future Soviet teachers have three or four different types of teaching duties during which they are alternately supervised and left to their own initiative.

The pedagogical institute curriculum divides into three parts: (1) professional subjects concerned with teaching; (2) required and elective courses in the subject field; and (3) courses common to all students in the institute. The average lecture load of students majoring in one of the seven basic subject matter specialties (chemistry, physics, mathematics, history, geography, natural science, Russian language and literature) is 3,800 hours during a four-year pedagogical course. The average number of course examinations required is seventy, plus the final State examinations. Future teachers also complete an average of 600 - 800

hours of practice teaching plus an unspecified amount of other field practice during the four-year course. As a rule, the four-year pedagogical course and presumably the new five-year program calls for some 4,200 - 4,400 hours of training.

The course of study in a pedagogical institute includes: political economy, history of the Communist Party, physiology, elementary manual work in the workshops, a foreign language, physical culture, and military education, besides the general subjects in which the teacher will specialize, such as mathematics. The student is attached to one particular school and is given one problem on which to work under the supervision of an assistant professor. He begins by observation, which has to be followed by a written analysis of what he has seen and a report of his impressions. In the second stage he gives a lesson, the plan of which he must prepare for his supervisor, showing every stage in detail. The lesson is given in the presence of the supervisor, class teacher, and other students, all of whom will meet after the lesson for criticism. During practice the student must work on such problems as the importance of expeditions in school, discipline, self-government, out-of-school work with children, the preparation of lessons, the amount of matter a lesson should contain and its arrangement.

The program of studies for a four-year course in USSR pedagogical schools is given in Table 11. Homework, laboratory and practical work, assigned papers, and periodic tests must be completed and graded as satisfactory before students are permitted to take final examinations. This preliminary verification of the student's knowledge is the responsibility of the teaching assistants and instructors. Final course examinations

may be written, in which case two hours is allotted for answering the two or three questions asked. More often the examinations are oral and last approximately twenty minutes.

TABLE 11
PROGRAM OF STUDIES FOR A FOUR-YEAR COURSE IN RSFSR
PEDAGOGICAL SCHOOLS: 1955-56¹

Subject Program for Elementary School Teachers	Number of hours per week by year*				Total	Hours per indi- vidual sub- ject
	I	II	III	IV		
	2	3	4	5	6	7
Russian language and methods of teaching	---	---	---	---	440	---
Literature	---	---	---	---	495	---
Mathematics and methods of teaching	---	---	---	---	647	---
Arithmetic	2	2	2	1	---	248
Algebra	2	2	---	---	---	144
Geometry	2	2	2/-	---	---	182
Teaching methods	---	---	2/1	1/-	---	73
Physics	3	3	2/-	---	254	254
Chemistry and mineralogy	4/2	---	---	---	110	110
Natural science and methods of teaching	---	---	---	---	295	---
Geography and methods of teaching	---	---	---	---	270	---
History and methods of teaching	---	---	---	---	398	---
History of the Communist	---	---	---	4	128	128
Psychology	---	3/-	---	---	57	57
Pedagogy	---	-/4	2	2/1	190	190
History of pedagogy	---	---	---	2	64	64
Logic	---	---	---	3/-	54	54

¹Medynskii. *op. cit.*, pp.179-180.

*Two hours in a column indicate hours in first and second semester.

TABLE II--Continued

Subject	Number of hours per week by year*				Total	Hours per individual subject
	I	II	III	IV		
	2	3	4	5	6	7
School hygiene	---	---	---	2/-	36	36
Pennmanship and methods of teaching	1	1	1	---	108	108
Drawing and methods of teaching	2	2	2	1	248	248
Singing and methods of teaching	2	2/1	1/2	1	212	212
Physical education and methods of teaching	2	2	2	2	280	280
Practical work in shop and agriculture	-/2	2	2	1/2	224	224
Observation and practice teaching	---	-/2	2/4	4/-	212	212
Optional Subjects	---	---	---	---	---	---
Foreign language (English, French, or German)	---	---	---	---	280	280
Choral or individual singing	---	---	---	---	280	280
Total hours	33/34	34/36	36/35	35/28	5,282	5,282

In-service training

Soviet authorities have found teacher-training on a part-time basis an excellent method of helping teachers raise their professional qualifications while retaining their full-time teaching services. Part-time training through correspondence and evening courses is primarily a means

for raising qualifications of secondary school teachers. The number of students obtaining a higher education in the USSR on a part-time basis appears to have increased rapidly during the 1950's and by 1955-56 reportedly approximated one-third of the enrollment. In 1956-57 approximately 60,000, seventy per cent of whom are teachers, were graduated from extension training programs. Under the watchful eye

TABLE 12
DISTRIBUTION OF GRADUATIONS FROM SOVIET HIGHER
EDUCATIONAL ESTABLISHMENTS, BY FIELD, 1928-56¹

	1946-50 average annual		1954		1956 ²
	Thou- sands	Per Cent	Thou- sands	Per Cent	Thou- sands
Total graduations	130.3	100.0	173.0	100.0	210
Engineering.	32.0	24.6	53.0	30.6	65
Agricultural	10.1	7.8	18.0	10.4	22
Socioeconomic.	6.9	5.3	8.0	4.6	9
Educational.	59.6	45.7	70.0	40.5	85
Health	21.7	16.6	24.0	13.9	29
Additional:					
Party schools.	--	--	None	--	--
Extension training . . .	--	--	57.0	--	60
Grand total.	--	--	230.03	--	270

¹Pravda, June 25, 1955, editorial.

²Izvestia, June 25, 1955, an estimate.

³Pravda, July 5, 1954, editorial.

of the Soviet authorities, many aspects of the training have been found wanting. Specially designed textbooks, reference materials, and teaching aids are being prepared, and methods of checking written work are changing. The requirement that students be employed in the line of work they are studying appears to be more rigidly enforced than formerly.

The expansion of extension training is attributable to several factors. The particular prominence of extension training among educational field professionals is explainable on the basis of several decrees issued by the Soviet government in 1936 and especially between 1942 and 1944. These decrees established wage differentials for primary and secondary school teachers based on their education, and made legal the practice of appointing teachers only to those positions which coincided with their type of education. Intermediate and upper grade (V - X) teachers of secondary schools were requested to have higher education, and those who had not completed it were compelled to do so through extension training. Another factor directly related to the expansion of extension training is that regular higher educational establishments apparently are not able to accommodate the growing numbers of those who aspire to receive professional training. As a result, extension training is expanding because of Soviet efforts to enroll the growing numbers of secondary school graduates going directly to work in industry upon the completion of the ten-year school, but who wish to continue their education and cannot be absorbed by the regular facilities.

Correspondence courses, offered by some higher educational institutions since the 1920's, were not reported to have large enrollments until the end of the 30's. The reported number of graduates from such courses was

small, in fact, until around 1950 when extensive changes were made in the organization of correspondence training. The changes took place during the fifth five-year plan, 1951-55, so that by June 1954 almost 25 per cent of the graduates of higher educational institutions were said to have completed their training in part-time programs.

Correspondence study in the USSR is carried on through a reported 530 correspondence departments, at higher educational establishments, and twenty-three correspondence institutes. Correspondence departments maintained at various pedagogical institutes serve teachers in the surrounding area. There are three pedagogical institutes located at Moscow, Baku, and Erevan which function solely as correspondence institutes for teachers, chiefly for those in rural areas. The rules of admission to correspondence institutions and departments are similar to those for ordinary higher educational institutions except that there is no age limit. Those admitted must have completed a ten-year secondary education or its recognized equivalent, and have passed the competitive entrance examination for their major field. Besides the standard application required by Soviet universities and institutes, a part-time student must submit information from his place of employment on the type of position he holds and on his specialty.

Evening courses, revived in popularity following World War II, now appear to be playing an increasingly important role. In 1950, three evening institutes and ninety-one evening departments reportedly were maintained at ordinary higher educational institutions for students who were regularly employed and wished to major in a field closely related to their work. Like the correspondence-extension training programs,

evening courses appear to be particularly popular with teachers who wish to raise their professional qualifications. Length of study is one semester longer than in a full-time program even though night school students, like correspondence students, are exempt from practical training prescribed for regular students and from physical and military training. Students spend sixteen hours a week in lectures and additional time in laboratory and shop work, which they frequently are able to carry out on the job. Evening students in other respects must complete the identical program required of day students. They use the same books, cover the same syllabi, listen to the same professors, and take the same examinations. In their last semester they are scheduled for leave from their job for four months to prepare and defend their diploma projects or thesis and study for State examinations. During this time they are entitled to dormitory accommodations if required, and given a stipend.

The completion of the course at the technicum or institute does not relieve the teacher of the duty of further study. Every institute organizes refresher courses and study courses for teachers. There are special pedagogical institutes for improving the qualifications of teachers. The shortage of mathematics teachers is most keenly felt now in the secondary schools. To make good this shortage the pedagogical institutes have special evening and correspondence courses for teachers in primary schools who wish to work in the secondary schools.

There are numbers of teachers in primary and nursery-infant schools who have only received short-term training. The need was so great that the authorities were forced to take young men and women with only a seven years' schooling, give them an intensive three month's course, and then

put them in charge of a class. Every teacher is expected to attend some course. For the young and inexperienced very detailed help is given in the practice of teaching. The young teacher is given precise instructions with concrete examples. He is given very detailed information on planning a lesson, on method, on apparatus and its use. The pedagogical stations organize periodic education exhibitions. These are explained in great detail to the visiting teachers, and are found to be very helpful, particularly in more backward areas.

Conferences, trade unions, and exhibits

The most important teachers associations in the Soviet Union are the educational trade unions, which, somewhat like the training institutions, are organized according to the level of teaching service. Covering the Soviet teaching profession there are three: The Union of Preschool Workers, The Union of Workers in the Primary and Secondary Schools, and The Union of Workers in Higher Educational Institutions.¹ Nearly all the teachers belong to one or another trade union. Membership fees are listed as 2 per cent of base salary. Although membership is said to be voluntary, information available indicates that the eligible group belongs. Within each union there exists professional associations devoted to a particular field of level, such as an association of mathematic's teachers. The three teachers' trade unions are considered to represent the body of workers in Soviet educational establishments. They are charged with the responsibility of coping with the needs of their members. The trade union provides the teachers with sick-leave pay, vacation pay, and pensions after retirement.

¹I. I. Grivkov, Professional Organizations, The Year Book of Education (London; Evans Bros', Ltd., 1953), pp. 413-417.

The trade unions represent the will of the Communist Party and Soviet State and a force to compel the teaching profession to carry out the directives of the Party and the State. They are expected to exercise an active role in drafting legislation relating to the profession.

Component parts of teachers' trade unions have commissions concerned with teaching techniques, work load and pay of teachers and others in the educational system, cultural activities, housing and welfare, labor protection, and social insurance. Members of these commissions consist of paid full-time workers and of teachers who are said to volunteer their services. The Labor Protection Commission maintains labor-protection inspectors in the individual school administrations. Members of the Commission on Teaching engage in activities relating to standards of the profession throughout the country. They work on such things as:

(1) dissemination of information on teaching techniques of educators considered to be outstanding; (2) making available experienced teachers to assist new teachers; and (3) planning for conferences to be conducted on teaching methods. This Commission sees that teachers enroll in available night or extension programs. Members of the Cultural Commission are charged with attending to the cultural needs of teachers and their families. A large part of the money allocated in the State budget for cultural measures is channeled into these commissions to provide for the construction, maintenance, and operation of some two hundred Palaces or Houses of Culture for teachers located in the larger cities and regional centers. Approximately once a month a Rural Teachers Day is supposed to be held by these club houses. Teachers from outlying areas come to attend

lectures on science, literature, and art, and visit the theater or cinema, or attend performances by teachers' amateur groups.¹

The cultural commissions are also charged with some 245 libraries and over 5,000 mobile libraries which make the rounds of some of the rural districts. They maintain some twenty odd vacation hotels, nine health sanitariums (mainly in the Crimea, the Caucasus, on the Volga and elsewhere) plus some two hundred summer camps for children of members. Educational-cultural work organized among the local population by the cultural commissions is said to use the services of about 50 per cent of the USSR teachers as lecturers and as leaders of circles and projects.

Regional teacher's conferences, which are held in January and August, have been a means of bringing together teachers, heads of schools, members of local departments of education, members of educational ministries, and representatives of Party organizations concerned with the schools for the discussion of achievement, of methods of fulfillment of educational plans, and other problems. There, results of the previous semester work are summarized and recognition is given for achievements considered outstanding. An exchange of experience is encouraged and contact is made with new people, which is particularly stimulating to the teacher buried away in some remote place. Party-State policies which will affect the teaching program in the next term are presented and discussed. The conferences organize special methods committees and subject committees of the most experienced teachers. These are at the service of any teacher

¹Ibid., p. 417.

in any difficulty. Sample textbooks or pilot projects are scheduled for trial by teachers in designated schools. A Western observer found that the Soviet mathematics conferences and mathematics training were similar to those in the United States.¹

The Teacher's Cooperation Service in district centers caters to teachers in the district by organizing associations of teachers of Grades V through X according to subject taught. Veteran teachers direct these associations. It comprises about ten or fifteen of the most experienced teachers and educators in its district, and meets once or twice a month. Any young teacher can come to the association for help in any problem. The association organizes seminars for the teaching of special subjects such as mathematics. It selects experienced teachers to visit the young teacher in the class and then give constructive criticism. It appoints the best teachers, who are also the most active politically and socially, as supervisors for the district. The supervisor meets all new teachers, informs them of the latest methods, helps them to plan their work, to select textbooks and apparatus, and to organize expeditions. Their purpose is to make available knowledge gained through experience, develop typical lessons for young teachers, prepare model lesson schedules and plans for the coming term, arrange exhibits of work done by district school children, display new books and visual aids, and maintain a library.

Traveling education exhibitions occupy a prominent place in the education of mathematics teachers. By this means the latest educational knowledge has been brought to the teacher in distant regions

¹ New York Times, July 16, 1956. (By Harry Schwartz quoting Prof. Norman E. Steenrod of Princeton University).

or remote villages. The expert who accompanies the exhibition organizes discussion groups or a conference for further elucidation of problems.

Research

The RSFSR Academy of Pedagogical Sciences in Moscow is the chief educational research center for the USSR. A large proportion of advanced degree training in education is carried out there. The Academy was founded in 1943 to aid in the development of education and to disseminate information about education. It has the following functions: to carry out research on problems of general education, specialized education, kindergarten education, history of education, school hygiene, methods of teaching basic primary and secondary school subjects, and on problems of educational psychology; to aid in the planning and development of other research work in education; and to train postgraduate students and educators for staff positions in pedagogical institutes and establishments concerned with pedagogical sciences.¹

The Academy is composed of various research establishments. Each deals with specific types of educational problems:

1. Research Institute for the Theory and History of Pedagogy. The sections are: kindergarten education, didactics, poly-technical education, school studies, and the history of pedagogy.
2. Research Institute for Teaching Methods. Departments are: methods of teaching primary grades, historical-philological disciplines, physical-mathematical disciplines; methods of using school laboratory and shop equipment; etc.
3. Research Institute of Psychology.

¹Medynskii, op. cit., p. 198.

4. Research Institute of Defectology. Departments are: defectology and specialized psychology, educational practices for different types of handicapped children.
5. Research Institute of Physical Education and School Hygiene.
6. Research Institute for Education in the Non-Russian Schools.
7. Research Institute for Education in the Arts.
8. Leningrad Research Institute of Pedagogy.
9. The Natural Science Institute in Leningrad--conducts research in methods of teaching natural science, morphology of man, physiological chemistry, and the physiology of plants and animals.

Students enrolled in the field of education considered to be most promising are invited to work on special problems connected with the research activities of an institution. Student diploma thesis and projects usually are based on problems of concern to the department. University students are required to carry out some research activity each semester, to write it up, and submit reports of results as part of their training in techniques of conducting research. At many of the schools starting with the first year the students are required to develop themes and topics based on observations made during their summer practice period. Students are expected to participate in seminars and conferences arranged by the departments. Some of the student papers are read at such conferences. Soviet research mathematicians who make important discoveries are rewarded by a promotion and by increased pay, and also are entirely or partly free from teaching duties so that they can devote all or most of their time to research.¹

¹New York Times, July 16, 1956, op. cit.

Future teachers who graduate from a higher educational institution with honors (the top 2 or 3 per cent of their class) may apply for postgraduate study leading to the degree of Candidate of Pedagogical Sciences, and possibly the degree of Doctor of Pedagogical Sciences. Advanced degree work in education is available in the few colleges of pedagogical institutes whose laboratory and library facilities are regarded by the USSR Ministry of Higher Education as outstanding in a given aspect of pedagogy and whose teaching staffs are considered qualified to supervise the necessary research and advanced training in particular pedagogical specialities.

Every pedagogical institute has its corps of postgraduates, part of whose work consists in observation and research. It should be noted that every postgraduate must have completed at least three years of teaching. Many of them will have done considerably longer periods in all parts of the country under very varied conditions. The latter utilize their experience to help their own and their colleagues' research. The research students are divided up into groups of four to six and sent to a school for a certain period. Here they attempt to observe accurately and minutely all that takes place during a lesson. Everything is noted down, the subject matter, the teachers' approach to the lesson, his mannerisms, whether he hinders or helps the lesson, and his movements. At another time a group may be sent to study one phase only. For example, they may note the children's reactions to a given lesson or a teacher's use of language in a lesson. On one occasion the Boubnov Pedagogical Institute sent six of its research students to study the time wasted in a lesson on unnecessary phrases and gestures.

Each Union Republic has its own Central Research Laboratory. Each region of the more developed Republics has its own research institutes. In the case of pedagogical institutes, when the work has been analyzed and discussed with the professor, and the report drawn up with diagrams, charts, and graphs, it may be published by the institute for the use of those teachers connected with it.

The so-called experimental schools are in reality demonstration schools to which teachers from the surrounding districts come for help and inspiration. In these schools a considerable amount of research work is being carried on and within the framework fixed by the central authority certain minor, though valuable, experiments have been carried on, such as, the one to determine the right length of a lesson for different age groups.

The Commissariat of Education allows an extra grant for experimental schools. A not unexpected result of this has been that almost every other school which had a slight variation in method or organization called itself experimental, and claimed that grant.

The research work in the RSFSR has been under the direction of the Central Pedagogical Laboratory in Moscow. Over a hundred schools supply the laboratory with information. The laboratory began as the First Experimental Station of Narkompros. The aim of the laboratory is to discover the best methods and the best type of lesson through the demonstration (model) schools to help the general schools train active children for the building of Communism. For this, the Soviets have said that it is essential to have a groundwork of knowledge, of reading, writing, literature and language, and mathematics.

There are many institutes carrying on educational research. The research into education for national minorities and backward groups, which offers its own peculiar problems, has been carried on by the special institutes in Leningrad and Moscow, and with their help, by regional institutes of the national minorities.

Teacher education of mathematics teachers

Table 13 indicates subjects and hours required in Pedagogical Schools for Training Elementary School Teachers. Table 14 gives the curricula in pedagogical institutes and universities for the training of mathematics teachers. A careful examination reveals that the mathematics content is nearly equal in the curricula of the institutes and universities. A pedagogical institute student specializing to teach mathematics in Grades V through X is expected to spend nearly as much time in the study of mathematics as a future professional mathematician pursuing university training for advanced work. It should also be noted that with the exception of a few advanced topics such as differential equations, equations of mathematical physics, integral equations, calculus of variations, and theory of probability which in the university curriculum take up some 356 hours, the list of subjects is similar in both curricula. For the mathematical subjects which are common to both curricula, including such subjects as theory of functions of real and complex variables, the pedagogical student spends even more time than the university mathematics student for those subjects in the university curriculum.

TABLE 13

SUBJECTS OF INSTRUCTION AND CLASS HOURS IN THE FOUR-YEAR CURRICULUM,
 PEDAGOGICAL SCHOOLS, (BEYOND SEVEN YEARS OF GENERAL EDUCATION)
 FOR THE TRAINING OF ELEMENTARY SCHOOL TEACHERS IN THE
 USSR, 1952-53¹

Subject	Class Hours	Per Cent
Mathematics (arithmetic, algebra, geometry)	647	14.0
Pedagogy	190	4.1
History of pedagogy	64	1.4
Teaching observation and practice	212	4.6
Total hours in four years	4,612	

Prior to 1957 the pedagogical institute curriculum provided for only four years instruction. It now encompasses five years of training the same as the university. This addition of the extra year will probably improve the very crowded weekly schedule of thirty-six hours per week for the first two years, thirty hours per week for the next year and a half, and twenty-six hours per week in the final semester. The university term, by comparison, is five years with an average load of less than thirty hours per week during the first seven semesters, twenty-four hours per week in the eighth semester, and only sixteen hours per week during the ninth semester. The last (tenth semester) has no scheduled class hours, the entire time being available for work in preparation for the State Examination.

¹Medynskii, op. cit., p. 191. (Items selected from Table 10.)

TABLE 14

CURRICULA IN SOVIET PEDAGOGICAL INSTITUTES AND UNIVERSITIES

Subject	Institute ¹		University ²	
	Class Hours	Per Cent	Hours	Per Cent
<u>Education</u>				
Psychology	68			
Pedagogy	119		64	
History of Pedagogy	72			
Method of Teaching			—	
Mathematics	188		70	
Special Preparation	48			
Pedagogical Practice			60	
School Hygiene	18		248	
Practice Teaching	612			
	1,125	25.4	442	10.5
<u>Mathematics</u>				
Analytical Geometry	178		188	
Mathematical Analysis	437		476	
Higher Algebra	216		174	
Differential Geometry	65		100	
Foundations of Geometry	56		64	
Theory of Numbers			30	
Theory of Numbers and Theoretical Arithmetic	87			
Theory of Functions of Real and Complex Variables	116			
Theory of Functions of Complex Variables			100	
Theory of Functions of Real Variables and Functional Analysis			86	
Differential Equations			136	
Equations of Mathematical Physics			100	
Integral Equations			36	
Variational Calculus			30	

¹USSR, Rostov Pedagogical Institute, Mathematics Curricula, CENIS Tr1 Series, 56-2, 1956.

²USSR, Kharkov State University, 1955, Mathematics Curricula, CENIS Tr1 Series, 53-41, 1955.

TABLE 14--Continued

Subject	Institute		University	
	Class Hours	Per Cent	Hours	Per Cent
Theory of Probability			54	
Elementary Mathematics	412		70	
Drafting and Fundamentals of Descriptive Geometry			68	
Projective and Descriptive Geometry	106			
Drafting	64			
Electives			328	
Mathematical Praktikum	98		170	
Special Mathematics Seminar	100			
History of Mathematics	40			
	1,975	44.6	2,210	52.7
<u>Political</u>	504	11.4	504	12.0
General	260	5.8	406	9.7
General Science	564	12.8	634	15.1
TOTAL (Class Hours)	4,428	100.0	4,196	100.0
Distribution of Hours				
Lectures	1,954		2,054	
Lab	309		208	
Practical studies, seminars exercises, etc.	1,553		1,506	
Other			180	
Practice Teaching	612		248	
Total	4,428		4,196	

Section instruction in such subjects as mathematics, theoretical mechanics, physics, and foreign language, is common during the first two or three years of study. It usually consists of exercises and computational problems and is conducted by instructors. This type of instruction usually

requires specific homework assignments which must be passed regularly by the students and are usually graded. Another type of section instruction is the seminar. Seminar topics are broad and general during the first years to give the student an idea of the main problems in the field. Topics covering a more restricted area and dealing with specific problems are treated during the fourth and fifth years.

Summary

The Soviet Union, as many of the western nations suffering from a teacher shortage, has a vigorous teacher-training program. Although the teacher shortage does not seem to be significant or acute the demand for mathematics teachers is high.

The professional training of mathematics teachers follows the general pattern of teacher education. He is trained in one of three types of teacher-training institutions; pedagogical school, pedagogical institute or university. If he wishes to teach in Grades V to X he should be a graduate of a pedagogical institute or university. Whether at a university or a pedagogical institute the future mathematics teacher majors in mathematics and completes standard courses and specified courses in pedagogy, history of pedagogy, and methods of teaching mathematics. Table 11 indicates subjects and hours offered in pedagogical schools. The first part of Table 14 compares the hours devoted to professional subjects as offered by the institute versus the university. This table reveals the fact that professional subjects occupy 1,125 hours or 25.4 per cent of the total time in the pedagogical institute while 442 hours or 10.5 per cent is so allowed in the university. Thus a university

student who goes into teaching receives more instruction in mathematics but less in professional education courses.

Although the Republic Ministries of Education finance and maintain their own teacher-training establishments, the general supervision of standards is carried on under the USSR Ministry of Higher Education. The institutions involved in the training program are pedagogical schools, pedagogical institutes, and universities. The in-service training of the teachers is provided for by maintaining correspondence and evening courses. These courses are very popular and the enrollment totals about one-third of the total higher education enrollment.

Traveling education exhibitions are a permanent feature of the educational training for mathematics teachers. The exhibit itself brings to the teacher the latest educational knowledge plus the expert opinion of an authority in the teaching field. Besides the exhibits there are associations and conferences to which most of the teachers belong. The most important teacher association in the Soviet Union is the Education Trade Union. Under the trade unions are commissions concerned with such things as teaching techniques, workload and pay of the teachers, cultural activities, housing and welfare, labor protection, and social insurance. The regional teachers conferences, held in January and August, are a means of bringing the teachers, heads of the school, and members of local education departments, members of ministries, and Party representatives together for a discussion of achievement, methods, educational plans, and other problems.

The formal academic training of most teachers takes place in pedagogical institutes. The curriculum of such institutes divides itself into

three parts, namely, professional subjects, required and elective courses in the subject field, and courses common to all students in the institute.

The student studying to be a mathematics teacher carries an extremely heavy load. The lecture load alone is approximately 3,800 hours for the course. As a rule a pedagogical course calls for a total of some 4,400 hours. He takes approximately 2,000 hours of mathematics plus electives in his subject field. The result of this is that the student studying for the teaching profession in mathematics has little or no leisure time. It is significant that the mathematics training of the future mathematics teacher is practically as heavy as that of the professional mathematician. This concentration in the mathematics field is accomplished by exposing the student to a very heavy class hour schedule. This excessive load will likely be alleviated some by the addition of the fifth-year in the training course in the pedagogical institutes. There seems to be a trend to make the mathematics training course as subject specialized as is practical. There is no tendency to reduce the professional training of the future mathematics teacher in favor of subject training. The institute or university mathematics graduate with five years training will have the equivalent of a Master of Arts degree. It is a significant point that thus all future teachers will graduate with advanced degrees. Following the student-teacher after graduation and into the application of his training and looking at him as one working in the profession is the subject of the next chapter.

Chapter V

THE TEACHER AT WORK

The recent influx of students into Grades VIII - X has put additional burdens upon the Soviet teacher. It has meant that he is faced with a more mediocre student body, which may not be as interested, as well prepared, or as academically capable of mastering the curriculum. Teaching methods must now be modified and filled with practical examples and applications, partly to hold the students interest, partly to arouse it, and partly because these future graduates of the ten-year school will not all go on to higher educational establishments but will go to work in industry or elsewhere. The methods of instruction invariably stress traditional classroom instruction procedures. In all the syllabi at least 20 per cent of the time is devoted to repetition, the golden rule of the traditional school.¹

The class lecture is the principal teaching method. The lesson format commonly consists of a review of old material and an introduction to new material, an elaboration of new material and drill, needed repetition, an examination and verification of the student grasp of the new material, an explanation of homework assignment and instructions for carrying it out, and then a summation of the new material, including its integration with the over-all subject. Emphasis is placed on training pupils to listen attentively, to accept what they read and are told,

¹НКП, РСФСР (Peoples Commissariat of Education of RSFSR). Programmy srednei shkoly (Programs of the Secondary School), (Moscow, 1941).

and to repeat what they have been assigned to learn in a logical and grammatically correct written and oral form. According to the Soviet educators, time spent on memorizing does not handicap the pupil because there is no alternative way to master, for instance, mathematical formulas.

The amount of homework that a Soviet pupil might be assigned has been regulated by a 1952 special decree which indicated the maximum limits. The regulation states that for pupils in Grade I not more than one hour a day, for Grade II up to one and one-half hours, for Grades III and IV up to two hours, in Grades V and VI from two to two and one-half hours, for Grade VII from two and one-half to three and one-half hours, in Grades VIII to X from three to four hours.¹ The problem of overwork in recent years has been of particular concern to parents, educators, and school doctors.

Conditions under which teachers work

The emphasis on scientific and technical education has had its influence upon the curriculum and upon the methods of teaching. Pupils are assigned problems either worded in technical language or adopted directly from technical practice.

The student-teacher ratio is an important factor in the qualitative aspects of primary and secondary education. During the last decade there has been a considerable improvement in this ratio in the USSR. In the early 1930's the ratio was thirty-six students per teacher, in 1940, twenty-eight students per teacher, but by 1950 the student-teacher ratio had been reduced to twenty-three to one.² For a number of years the

¹The Current Digest of the Soviet Press, X, April 25, 1953.

²USSR, Narodnoye khozyaistvo SSSR (Sbornik) (Nat'l Economy of the USSR), (Moscow: No. 4, 1951), p. 424.

Soviet regime has expended effort to train a body of teachers numerically sufficient to insure a reasonable amount of individual guidance in the classroom. In the academic year 1954-1955 the pupil-teacher ratio was reported to be eighteen to one in the regular primary-secondary schools, and in 1955-1956, seventeen to one.¹

The influence of Communist youth organizations on the teacher and the teaching methods must be mentioned. In the 1920's and at the beginning of the 1930's, Communist youth organizations, both the Young Communist League (Komsomol) and its outlet for younger children, ages nine to fourteen (Pioneers), caused considerable interference with the actual day-to-day operation of and the teaching in primary and secondary schools. In the Soviet Union there is the conviction that no subject, including mathematics, can be divorced from political implications. In practice this means that the teaching of mathematics must conform to Communist ideology. According to Mikhailov the organizations of the Komsomols and Pioneers give valuable assistance to school directors and teachers in the training and teaching of students.² The Communist Party and Government have transmitted orders of capital importance to the teaching profession with relation to fundamental problems of teaching and training and to the end of raising the general level of the Soviet school.³

¹U. S. Dept. of Health, Education and Welfare, Circular No. 467, *op. cit.*, The average ratio in U. S. public schools in 1955-1956 was 27 to 1. p. 2.

²Speech given by N. Mikhailov, Secretary to the Young Communist League, May 19, 1952, at the celebration of the founding of the Pioneers.

³Pravda, October 5, 1949.

Today these two political organizations, Pioneers and Komsomols, have become a useful tool in the hands of the regular school administration and the Soviet teacher. Their function is to aid the teacher and the school administration in maintaining discipline, in promoting learning, and in co-ordinating extracurricular activities.

There is one important device which is designed to enforce uniform standards of learning and to foster adherence to the centrally prescribed syllabi of instruction. Each ministry of education maintains a staff of inspectors who visit schools in their assigned areas. These inspectors are concerned not only with school accommodations or buildings but also and primarily with the quality and program of classroom instruction. They are generally appointed from among those considered to be the better teachers. They work with the school head and share in some measure responsibility for the schools representation. Their primary function is to insure approved teaching standards in the schools. They sit in on lessons and examinations, survey Party youth organizational work, check on school discipline, review teaching problems with the staff and check on the teacher's performance, note the adherence to standard grading techniques and to the prescribed coverage of instructional material in any given subject. They may make sudden appearances in classrooms, examine the teaching record in which the teacher enters topics covered during the instructional period and home assignments, and check the student record book in which the teacher keeps a record of grades received by a pupil during the year in oral and written quizzes and recitations. Finally the school inspectors may order written examinations for the entire class or may quiz orally individual pupils. Some former teachers have

commented that, since inspectors have been teachers who had achieved a certain amount of success in their profession, they were able to help solve local school problems through their direct contacts with the Ministry. They represent the Party and the State in insuring that official policy and procedure are carried out in the USSR schools.

Since the early 1930's Soviet educational authorities have established standard grades and quite elaborate rules for grading procedures. There are five numerical grades, 1 to 5, with a passing grade of 3 or higher. Before World War II the teacher's own performance was subject to judgment by Soviet educational authorities on the basis of the rate of passing grades his students received. This phenomena was a motive for some of the laxity in grading which was in existence at the time. During the War, however, numerous regulations were issued designed to put an end to this erroneous practice. Various steps were taken to restore and to uphold the academic code in grading. From various accounts appearing in the Soviet press, biased grading and favoritism have not disappeared entirely but have undoubtedly been curtailed drastically in the last few years. The Soviet teacher is faced with the dilemma of adhering to a standard curriculum and rigid grading requirements and at the same time of meeting the mass-oriented standards of learning with the inherent pressure to see that his students receive passing grades.

The teaching load of a Soviet teacher is quite heavy. In the elementary grades he teaches all the subjects offered, which amounts to about thirty teaching hours per week. In the intermediate and upper grades, the time spent in instruction each week is from eighteen to twenty-four hours. When all the other activities which he is required

to pursue (grading, class preparation, staff meeting) are considered, the total time invested by the Soviet teacher is probably forty hours a week. The number of hours per week does not tell the whole story. The teacher of mathematics works five days and has the sixth day off in urban schools, and works six days with the seventh off in rural schools. During the summer the teachers get two months as holidays. The rest of the time has to be spent in conferences, discussions, and the preparation of syllabi and the necessary apparatus. Although two-week holidays are scheduled in the winter and the spring, during this time the teachers must be prepared to spend it in conference, discussion, and preparation. The school day lasts from four and one-half to six hours. However, in the rural schools, where the week is longer, the day is shorter.

There is a great deal of pooling of experience within one school as well as outside. There is no evidence of a case when a mathematics teacher kept to herself her particular good ideas and their applications. To the modern Soviet mathematics teacher such an attitude would be incomprehensible. This atmosphere of co-operation and good will is a striking feature of the teaching profession.

The profession makes great demands on the Soviet teacher. Conscientious Soviet teachers of mathematics, at present, have very little leisure. Their free time is not given up to self-improvement. They are also expected to interest themselves in the childrens' out-of-school activities and to take an active part in the political and social life surrounding them. This is particularly the case in the village, where the teacher is the starting point and center of all the cultural activities. They are often called upon to volunteer to teach the illiterate or

semiliterate in factory or farm. Sometimes these services are paid for, but more often they are regarded as social obligations of the teacher, and are therefore, unpaid. The teachers have to help to initiate library reading rooms and Read Corners for the adult population. Once a month the class teacher is expected to visit the homes of the younger pupils. At school he must be present at parents' group discussions on the care and upbringing of children. The Soviet teacher has to spend considerable time writing up notes of lessons. Very detailed records of the pupil's psychological, social, as well as intellectual progress have to be kept.

Pupils having difficulty are given extra lessons and extra coaching by the mathematics teachers or by an older pupil. In addition, schools organize special courses during the summer and winter holidays in those mathematics subjects in which pupils need extra help. There is evidence that it is considered a reflection on the ability of the teacher if less than 90 per cent of the class pass the examinations.

Daily work is evaluated through homework assignments, oral recitations in class, and periodic tests. Marks are entered in the record book of each pupil which he keeps with him and which is to be signed by the child's parents each week. Pupils who receive an "unsatisfactory" in mathematics may take repeat examinations in the fall after completing summer review sessions. Those who receive more than two unsatisfactory marks or who fail a subject are required to repeat the grade. The repeater problem is an important one for the primary teacher. Most of the repeaters in the primary grades have failed in arithmetic, in Russian, and in the native language.

The appointment of a graduating student to a teaching position is in answer to a request from a school. Following his graduation from one of the teacher-training institutions a student is assigned for a period of three years to the school requesting a teacher with mathematics training. At the end of his obligatory teaching assignment, the teacher may be transferred to another school through choice or consent or may leave the profession. Some teachers apply for postgraduate study in education at this time. If a student is assigned elsewhere than to his native region, he is given some orientation information about the area. If it is an agriculture community, he is supposed to be informed on its agricultural problems and the equipment used. He should know what the people are like and principal community activities, interests, and traditions. Soviet teachers are expected to be active participants in community projects and to help solve various problems that arise. In villages the teacher usually is a link between the Party-State and the local inhabitants.

In theory Soviet teachers receive their appointment for life or until eligible for retirement and pension after twenty-five years of service. In practice the Soviet teacher has no job security should the local Department of Education or Party committee file a complaint for incompetence.

Teacher promotion is not a burning question in the USSR. There is such a shortage of people for higher posts and headships that the competition is for teachers and not for posts. Any good teacher is quickly discovered and given a promotion. Political and social activity is always taken into consideration. Other things being equal, the

candidate who can show a good record of these activities is given preference. So far the need to work out a system of promotion has not arisen. There is seemingly complete equality between the sexes so that sex supposedly plays no part in deciding appointments.

The teachers, Pioneer leader, and librarian together with the school director and his deputy form the academic council of the school. Meeting at least once a month, the council reviews current difficulties, implements policy decisions from the ministry, and discusses general school problems. The teachers not only take part in the function of the academic council, but also are members of the Methods Committee in larger schools. The committee includes a methods expert and child psychologist. These committees thrash out problems of teaching, planning of lessons, textbooks, expeditions, self-government, and discipline. The senior teacher in the school is expected to help the junior. Periodically the senior teacher is present at a lesson given by the junior. At the end of the lesson he praises what is good, shows where improvement is necessary and possible, and how this may be achieved.

Finally, perhaps the most important too, is the favorable condition under which the mathematics teacher works, namely, the excellent relationship that he enjoys in the community. The relationship is a congenial one and the position is one of prestige. He is surrounded by an atmosphere of friendliness and co-operation. This, as the Soviet teacher readily admits, goes far to compensate for the strain of too much work.

Salary

Soviet teachers are paid by the State under a graduated scale for various categories of teachers.* These categories depend upon length of teaching service, education, grade level and subject taught, and particular place in which the teaching is done. In practice, according to RSFSR Deputy Minister of Education, most teachers in the Soviet Union earn about double their base salary because they work twice the number of hours specified. Teachers in the cities frequently teach a double shift. In rural areas, where there is ordinarily only one shift, teachers instruct young people and adults in evening schools and in part-time programs. A teacher in the city school earns more than one in a country school, while a teacher in a country school receives housing including fuel and light, and if he has dependents, he is supposed to receive an allotment of land and grazing rights for such livestock as he is allowed to own. Those teaching in certain isolated areas of the USSR are expected to have a 20 per cent wage differential. Teachers working in schools beyond the Arctic Circle (Murmanak, Archangel, or in the far northeast, Kamchatka) are supposed to receive a 50 per cent automatic increase in their base salary as are teachers of certain tribes of northern peoples and certain other ethnic minority groups. Teachers in schools for children with mental or physical handicaps, by law, are supposed to receive a 25 per cent increase in their base salary to compensate for the difficulty of their work. The honorary title of "Teacher of Merit"

*See Table 15.

entitles the holder to an additional one hundred rubles a month, as does the possession of an advanced academic degree.

Besides extra money for additional hours of teaching, they may receive extra pay for hours spent in such duties as checking written exercises and examinations, acting as the school librarian if one is not on the staff, acting as class counselor, and directing extracurricular clubs or activities. After twenty-five years of service, a teacher is supposed to receive a pension equal to 40 per cent of his most recent base salary, whether he retires or continues to teach. He is supposed to retain his salary during illness, receive medical attention, and have a two-month summer holiday.

The Soviet teacher of mathematics enjoys some advantages over the nonteacher. He has been placed in the first category for rations, salary scale increased, and housing accommodations improved. Teachers have been given extra house-room to allow for study. They have been supplied with books at a reduced price. Their children have been given special preference in secondary and higher education. Their sons and daughters who attend universities or institutes receive maintenance grants. The teachers themselves are encouraged to attend various free courses of from two days to a month to one, two or three years. Through the Educational Workers Union they obtain at a very low price tickets for the theater, the concert, and the opera.

TABLE 15

SALARY SCALE, 1955¹

Position	Rubles per Month*
Professor	
Head of department- - - - -	6,000
Leader in research institute- - - - -	6,000
Academic rank not indicated - - - - -	5,000
Docent	
Head of a department, degree not stated - - - -	3,200
Upper level - - - - -	3,200
Minimum - - - - -	2,500
Secondary School Teacher	
Beginner (depending on hours) - - - - -	800 to 1,200
Grade unspecified - - - - -	700
Nonacademic Wages	
Truck driver- - - - -	700
Laborer - - - - -	300
Street cleaner- - - - -	250

Professional journals

Soviet teachers have professional journals devoted to various fields and levels to help them in their daily work. Teachers in the secondary schools have access to such journals as: Mathematics in the School; Herald of the Higher School; The Primary School; Preschool Education; and a journal devoted to parent-teacher problems, The Family and the School. The professional triweekly newspaper, Teachers' Gazette, the

¹Korol, op. cit., p. 306.

*A ruble varies from 10 cents to 25 cents but in most instances is the former.

joint organ of the Republic Ministries of Education and the Primary and Secondary Teachers Trade Union, publishes articles, notices, pictures, and items of interest to mathematics teachers. The political journal, the organ of the RSFSR Academy of Pedagogical Sciences, Soviet Pedagogy is a monthly magazine. Its pages contain the major articles of the nations' most respected educators and other pedagogical authorities. Sections are devoted to general educational theories and practices, history and development of pedagogical ideas, book reviews, articles on teacher-training and the practice teaching of education majors, and reviews of research in Soviet pedagogical higher educational institutions and the pedagogical academies research institutes. In addition, the educational publishing houses of the various republic ministries of education and the RSFSR Academy of Pedagogical Sciences issue books and pamphlets on teaching, manuals on methods, and collected works by teachers describing experiences in handling particular problems.

Summary

The Soviet teacher works in a rather formal classroom atmosphere but enjoys a student-teacher ratio of seventeen to one. The principal teaching method employed is the class lecture. The amount of homework that she may assign has been regulated by a special decree for the various grade levels. Soviet educational authorities have established standard grades and an elaborate ruling for grading procedures. Although grading favoritism has almost entirely disappeared in the last few years, the Soviet teacher is faced with trying to follow a standard curriculum and

a rigid grading system and at the same time of meeting the standards of learning with the constant pressure of having his students receive passing grades.

The teaching load of the Soviet mathematics teacher is rather heavy. Although the actual instruction time is from eighteen to twenty-four hours he spends upward of a forty-hour week when such requirements as grading, class preparation, and staff meetings are considered. The average teacher spends considerable amount of time in conferences, discussions, and preparation of syllabi. Even the two-week holidays, winter and spring, are spent in conferences, discussions, and preparation of lessons.

The profession demands a great deal from the Soviet teacher. The mathematics teacher in the Soviet Union has little or no leisure time. He is expected to interest himself in children's out-of-school activities, take an active part in the political and social life of the community, volunteer to teach the literate or semiliterate, help in the library reading rooms, and visit the homes of her pupils. Often he is called upon to give extra lessons and extra coaching to the pupils who are having difficulty in mathematics.

The securing of a teaching position for a graduating student is no particular problem in the Soviet Union. The appointment to a teaching position is in answer to a request from a school. After graduation from one of the teacher-training institutions, a student is assigned for a period of three years to the school requesting his type of training. At the end of the three years tour of duty, the teacher may be transferred to another school either through choice or consent or he may leave the

profession. It is at this time that the most teachers apply for post-graduate work. In theory the Soviet teacher receives his appointment for life and is eligible for retirement and pension after twenty-five years of service. Actually, however, the Soviet teacher has no job security in case the local department of education or even Party committee should file a complaint for incompetency. His promotion, on the other hand, is assured if he is a competent teacher. There is a constant teacher shortage in the field of mathematics. A good teacher is quickly discovered and given a promotion.

The Soviet teacher enjoys the condition of working in a congenial ^{sited} atmosphere with his colleagues. There is a free exchange between teachers of particularly good ideas and their application. This atmosphere of co-operation and good will is one of the outstanding features of the teaching profession. He enjoys, also, an enviable position in the community in which he lives. His relationship with the community is a congenial one and his position is considered one of considerable prestige. He finds the community a friendly and co-operative one. This condition the teacher readily admits goes a long way to compensate for the heavy teaching load and other unpleasant features of his position.

The salary of the Soviet teacher is paid by the State under a graduating scale. Depending on such things as length of service, education, grade level taught, subject taught, and particular place in which he teaches. Teachers in the cities frequently teach a double shift thereby doubling their salary. Those teaching in certain isolated areas or under difficult conditions are given a certain per cent increase

in their base salary to compensate for the difficulty of their work. At the end of twenty-five years of service a teacher receives a pension equal to 40 per cent of his most recent base salary.

In some respects the Soviet teacher enjoys some distinct advantages. His salary is good, housing accommodations are improved, extra house-room is allowed for study, books may be purchased at a reduced price, and children are given special preference in secondary and higher education.

As a specific aid to his teaching, the Soviet teacher enjoys the availability of several professional journals. Some of the journals pertain specifically to his subject, while others are written particularly for his grade level. In these periodicals there are sections dealing with general education theories, history and development of pedagogical ideas, book reviews, teacher-training ideas, and reviews of research in the field.

Chapter VI

TRENDS AND SUMMARY

Embracing an all important driving goal of being superior in science and technology, the Soviet Union is pushing mathematics education. The educational policy of the USSR is affected by the problem of concentrated centers of population, a wide variety of racial strains and cultural traditions, a diversity in climate, and sparsely populated remote areas. In spite of these handicaps the principle of free and universal education has been adopted as a national policy and is in the process of implementation in the USSR. Education is now compulsory through the seventh grade and is offered through the tenth with ten years of compulsory education as the goal for 1960.

The mathematics curricula throughout the USSR has uniformity as the one dominating characteristic. This distinctive feature of Soviet mathematics education appears on all levels of the secondary school. The material to be covered and the homework assignments for each mathematics course is given in the syllabus for that course. The mathematics textbooks for the courses are prepared, published and revised under strict supervision by the State. The mathematics teacher is limited to those texts that are approved by the State. The texts in most cases are reprints of books whose contents have remained the same for many years. Most mathematics textbooks are brought up-to-date through revision rather than replacement. Although the mathematics teacher has no choice of

textbooks, he is free to provide any supplementary material or information that has been officially approved for publication.

The kindergarten teacher has the responsibility of getting her pupils to the level where they are able to count up to twenty or thirty, add and subtract one digit numbers, and to use simple units of measure. The elementary school teachers, in the first four grades (students of age seven to eleven) through some 200 hours of instruction in arithmetic, cover the fundamental operations on whole numbers, and addition and subtraction of fractions. The fifth grade (students of age eleven to twelve) teacher in the area of arithmetic covers the multiplication and division of fractions, decimals, percentages and proportions.

In each of the Grades I through X of the Soviet secondary school, six hours of instruction per week are devoted to mathematics. In the sixth grade mathematics is divided into two hours for arithmetic, two hours for algebra, and two hours for plane geometry. Time devoted to mathematics in the seventh and eighth grades is divided equally between algebra and geometry, each having three hours. In the ninth and tenth grades time is divided equally, two hours each for algebra, geometry and trigonometry. Calculus is not taught as a formal subject in the secondary schools, but it is studied by individuals in many of the mathematics' circles (clubs) in the schools of the Soviet educational system. The total number of hours spent on mathematics in Grades V through X is approximately 1,200. Of the amount of time allotted for subjects required for graduation from Soviet ten-year secondary schools, mathematics occupies over 20 per cent of the total. It is significant that there seems to be the tendency of apparently failing to experiment with and modify the high

school mathematics curriculum. All graduates of the tenth grade, therefore, have had mathematics through trigonometry. It is significant, then, that approximately 18 per cent of Russian youth of age seventeen to eighteen successfully complete the fourth year of high school mathematics.

The training of mathematics teachers in the Soviet Union is concentrated in three types of institutions, namely pedagogical schools, universities, and pedagogical institutes. The kindergarten and primary school teachers are trained in the pedagogical schools while the teachers for Grades V through X are trained in pedagogical institutes and universities. Soviet authorities have found teacher-training on a part-time basis an excellent method of helping mathematics teachers raise their professional qualifications while still retaining their full time teaching position. In 1956-57 approximately 42,000 teachers were graduated from extension training programs alone.¹ Of the total graduates, approximately five times as many of the teachers come from the pedagogical institute as from the university. It is estimated that the same ratio applies to mathematics teachers. Of these graduates, 87 per cent of the elementary (Grades I to IV) teachers and 72 per cent of the secondary (Grades V to X) teachers are women illustrating the predominance of women in this profession.

Instruction for future mathematics teachers in higher education institutions is based on curricula approved by the USSR Ministry of Higher Education. It is the Soviet practice to approve a single standard curricula for mathematics, permitting variations only in the most advanced courses. The required subjects and number of hours are identical for all higher schools in which the same majors are offered. Whether at a

¹Pravda, 5 July 1954.

university or a pedagogical institute, the future mathematics teacher majors in mathematics and completes standard courses in Communism, a foreign language, physical education, and specified courses in pedagogy and methods of teaching mathematics. The lack of general education background for mathematics teachers is quite evident in the standardized curricula. There seems to be no tendency to increase this area of training above its present 260 of a total of 4,400 hours.

The elementary school teacher taking her training in a pedagogical school spends over 600 hours in mathematics including such subjects as arithmetic, algebra, and geometry. The time devoted to mathematics is approximately 14 per cent of the total for the four-year course. The future elementary school teacher spends 190 hours on the subject of pedagogy and sixty-four hours on the history of pedagogy with teaching, observation and practice occupying over 200 hours.

Since 1957 both the pedagogical institute and the university have had five years of training in their curricula. The average load in the university for the mathematics student is thirty hours per week during the first seven semesters, twenty-four hours per week in the eighth semester, and only sixteen hours per week during the ninth semester. The tenth and last semester has no scheduled class hours, but the entire time is available for work in preparation for the State examination.

The future mathematics teacher of Grades V to X enrolled in a pedagogical institute spends 45 per cent of his time in the field of mathematics, while his counterpart in the university devotes 53 per cent of his time in like manner. The mathematics course includes such topics as analytic geometry, mathematical analysis, higher algebra, theory of

numbers, theory of functions of real and complex variables, projective and descriptive geometry. The next largest area of study is that of education in which more than 25 per cent of his time is spent covering some 1,125 hours of instruction if he is in a pedagogical institute, or 442 hours or approximately 11 per cent if he is enrolled in the university. The educational curriculum includes such subjects as psychology, pedagogy, history of pedagogy, pedagogical practices and methods of teaching mathematics. The mathematics teacher enrolled in the pedagogical institute spends more than 600 hours in teaching and field practice. If he is enrolled in the university, he spends approximately 250 hours in this area. Thus by comparison the university student studying the teaching of mathematics spends more time (approximately 8 per cent) in the field of mathematics but considerably less time (less than one-half) in the area of education and practice teaching than his counterpart in the institute.

The recent increase of students into Grades VIII through X has put additional responsibilities upon the Soviet teacher. He is now teaching a less select group which may not be as interested or as well prepared as in the past. His teaching methods must now be altered to fit the group. He must introduce practical examples and applications to hold the students interest and to fulfill the need of those students of the ten-year school who will not go on to higher educational establishments. Many in his present class will go to work in industry rather than continue their education.

The syllabus in the secondary school mathematics course calls for at least 20 per cent of the time to be devoted to repetition. The usual

teaching technique consists of a review of old material, an introduction to the new material, an elaboration of the new material, repetition, examination and verification of the understanding of the new material. In making new assignments the mathematics teacher is limited by a special State decree of not giving more than two hours of homework in Grades V and VI, with the time ranging up to four hours for Grades VII to X.

The supervision of the mathematics teacher is maintained by the Ministry of Education who appoints a staff of inspectors made up of the better teachers. They visit schools in their assigned areas. The primary function of this group is to insure approved teaching standards in the schools. They are interested in lesson plans, examinations, school discipline, teaching problems and standard grading techniques.

The Soviet teacher in the elementary grades teaches some thirty hours per week and covers all the subjects. Eighteen to twenty-four hours of instruction each week is spent in the intermediate and upper grades by the mathematics teacher. However, when all the other activities are considered, the total time invested by the Soviet mathematics teacher is probably nearer forty hours a week. He spends much of his supposedly "off time" in conferences, discussions, and preparation of syllabi.

Working under strict supervision and a rather heavy total load, the teacher finds that the profession makes additional demands on his time. He has very little leisure time. The Soviet mathematics teacher finds that he is expected to take an active part in the political and social life surrounding him. He realizes that he is the center of the cultural activities of the village in which he teaches. His time is

taken up with extra lessons and extra coaching in the field of mathematics. The Soviet mathematics teacher finds there is compensation for all this extracurricula activity. As a teacher his relationship with the community is a congenial one, and his position is one of prestige. He is surrounded by an atmosphere of cooperation and friendliness. This attitude he frankly admits goes a long way to compensate for the strain of the heavy work load and the supervision imposed.

Acquiring the position of a teacher of mathematics in the secondary school is no particular problem. He gets his teaching position in answer to a request from a school. Since mathematics teachers are constantly in demand, he quickly gets an assignment for a period of three years. Promotion in this position is not a vital question in the USSR. There is such a shortage of people for higher posts and department heads that the competition is for teachers and any good teacher is quickly discovered and promoted.

The Soviet mathematics teacher is paid by the State under a graduated scale. It is determined by the length of teaching service, education, grade level, and particular place in which the teaching is done. He enjoys a salary better than the nonacademic wage earner and has the opportunity of doubling his base salary by teaching double time. After twenty-five years of service, he receives a pension equal to 40 per cent of his most recent base salary.

Mathematics education—educational philosophy, school system, kindergarten through Grade X, curricula, teacher training, and teacher working conditions—in the Soviet Union may be summarized rather briefly. The mathematics teacher after two to five years of education, weighted

heavily with mathematics and education courses, teaches as a respected professional in an atmosphere completely controlled and supervised by the State. The teaching curriculum is uniform and includes the standard subjects of arithmetic, algebra, geometry, and trigonometry required of all students. He enjoys the position of being an important part of mathematics education which the State admits is the basis for the Soviet goal of scientific and technological superiority over the West.

APPENDIX A. BILETY IN ALGEBRA¹

Bilet No. 1

1. Groupings and their types. Number of ways of arranging "m" elements in groups of "n". Number of permutations of "m" elements.

2. Problem or example.

3. Quadratic equations. Complete and incomplete quadratic equations. Solution of quadratic equations of the type:

$$(a) \ x^2 / px / q = 0 \text{ and } (b) \ ax^2 / bx / c = 0$$

Bilet No. 2

1. Combinations. Numbers of combinations of "m" elements in groups of "n".

$$\text{Equality: } C_m^n = C_m^{m-n}$$

2. Problem or example.

3. Analyzing the roots of a quadratic equation by discriminant and coefficients.

Bilet No. 3

1. Product of binomials, which differ only in their second terms.

2. Problem or example.

¹Main Administration of Schools of the Ministry of Education in the USSR. Official pamphlet published in the USSR. Uchpedgiz, 1955. Sets of questions (Bilety) given at the examinations leading to the certificate of graduation from the ten-year, 1954-55 academic year.

3. Finding a certain percentage of a given number and the reverse problem.

Bilet No. 4

1. Newton's binomial theorem (derivation of formula).
2. Problem or example.
3. Expressing the sums and products of the roots of a quadratic equation through its coefficients.

Bilet No. 5

1. Equality of coefficients of the terms equidistant from each end of the binomial expansion. General term of the formula in Newton's binomial. Sum of binomial coefficients.
2. Problem or example.
3. Expressing a second degree trinomial in the form of linear factors.

Bilet No. 6

1. Imaginary number. Complex number. Imaginary unit of a complex number. Conditions which make a complex number equal to zero. Conditions of equality of two complex numbers.
2. Problem or example.
3. Exponential function. Properties of exponential function and its graph.

Bilet No. 7

1. Addition and subtraction of complex numbers written in algebraic form.
2. Problem or example.
3. Logarithmic function, its properties and graph.

Bilet No. 8

1. Multiplication and division of complex numbers in algebraic form.
2. Problem or example.
3. Arithmetic progression. Summation formula for the terms of an arithmetic progression.

Bilet No. 9

1. Geometrical interpretation of complex numbers. Trigonometric form of a complex number.
2. Problem or example.
3. Finding per cent ratio of one number to another.

Bilet No. 10

1. Analysis of the quadratic trinomial (discriminant of the trinomial being a positive number)..
2. Problem or example.
3. Logarithm of a product.

Bilet No. 11

1. Inequality. Basic properties of inequalities. Addition and subtraction of inequalities.
2. Problem or example.
3. Logarithm of a quotient.

Bilet No. 12

1. Inequalities of the same and of opposite sense. Theorem about the sense of inequalities when the same number is added to each side of the inequality. Consequences of this theorem.
2. Problem or example.
3. Logarithm of the power and the root.

Bilet No. 13

1. Theorem on the sense of inequalities when both parts are either divided or multiplied by a positive or a negative number.
2. Problem or example.
3. Common logarithms and their properties.

Bilet No. 14

1. Solution of a first degree inequality with one unknown.
Solution of a system of such inequalities with one unknown.
2. Problem or example.
3. Linear function and its graph.

Bilet No. 15

1. Analysis of linear equations with one unknown.
2. Problem or example.
3. Formula for any term of an arithmetic progression.

Bilet No. 16

1. Analysis of a system of two linear equations with two unknowns.
2. Problem or example.
3. Direct proportional relationship and its graph.

Bilet No. 17

1. Analysis of a quadratic trinomial (with the discriminant of the trinomial being a negative number or equal to zero).
2. Problem or example.
3. Proportion. Basic property of proportion. Finding of the unknown member of a proportion.

Bilet No. 18

1. Solution of a second degree inequality with one unknown.
2. Problem or example.
3. Ratio of two numbers. Substitution of a ratio of fractions by a ratio of whole numbers.

Bilet No. 19

1. Bezou's $\overline{Y}$ theorem and its implications.

2. Problem or example.
3. Inverse proportionality and its graph.

Bilet No. 20

1. Solution of binomial equations of the third, fourth, and sixth degrees.
2. Problem and example.
3. Geometric progression. Formula for any term of a geometric progression.

Bilet No. 21

1. Solution of trinomial equations.
2. Problem or example.
3. Sum of the terms of a geometric progression.

APPENDIX B. EXAMPLES OF ENTRANCE EXAMINATIONS FOR
HIGHER EDUCATION ESTABLISHMENTS

Most applicants for admission to schools of higher education must take an oral examination in mathematics, and applicants to engineering schools and science faculties of the universities take a written test also.

Entrance examination in mathematics includes three sections with subdivisions as follows:

1. Arithmetic and Algebra
 - a. Real and complex numbers
 - b. Transformation of algebraic expressions
 - c. Equations; inequalities; functions and their graphs
 - d. Progressions
 - e. Logarithms
 - f. Theory of permutations and combinations; binomial theorem
2. Geometry
 - a. Plane geometry
 - b. Solid geometry
3. Trigonometry
 - a. Definitions and basic properties of trigonometric functions
 - b. Transformation of trigonometric expressions and solution of trigonometric equations
 - c. Solution of triangles

Examples of Problems Assigned in a Written Entrance Examination Given to the Applicants for Admission to the Mechanics-Mathematics Faculty, Moscow University in 1953

The following six problems constitute one of the sets assigned in the written entrance test in mathematics. It is not known how much time was allowed for this particular examination; two hours is the duration usually mentioned in Soviet sources with reference to the written tests.

1. Within a hexagon the side of which is equal a , place a square of largest possible size. Find the side of this square.
2. It is known that $\sin \beta = 4/5$. What is the value of this ratio:

$$\frac{\sqrt{3} \sin (\alpha / \beta) - 2 \sec \frac{\pi}{6} \cos (\alpha / \beta)}{\sin \alpha} = ?$$

(consider β being both an acute and an obtuse angle)

3. Two spheres are placed within a regular pyramid with a hexagonal base. The first sphere touches the base and all the six sides; the second sphere rests upon the first sphere and also touches all the sides of the pyramid. Find the ratio of the volumes of the two spheres.
4. Two factories received an order for an identical number of machines. The first factory started 20 days earlier and finished the work 5 days earlier than the second factory. At the moment when the number of machines made by both factories taken together was equal to one-third of the total number on order, the number of machines made by the first factory was four times the number produced by the second.

The first factory worked on the order altogether x days, producing m machines per day; the second factory worked y days, producing n

machines per day. Find those of the quantities x , y , m , and n , and those of ratios $x:y$ and $m:n$ which can be determined from the data given in the problem.

5. Which values of x fulfill the inequality

$$\frac{1}{x} < \frac{1}{x-1} - \frac{1}{2} ?$$

6. How many six-cipher numbers are there in which three ciphers are even numbers and three are uneven?¹

Note: A zero is an even number; it is understood that a zero is not to be used as the first cipher of a six-cipher number.

Collections of Mathematical Problems (Presented on Entrance Examinations for Higher Educational Establishments). 1951

Arithmetic and Algebra

I. Real and Complex Numbers

1. Natural numbers: resolution into common factors, the least common multiple and the least common denominator.

2. Rational numbers: basic arithmetic operations and their properties, decimals and common fractions, and repeating decimal fractions.

3. Involution to a power and the extraction of roots from numbers; the concept of irrational number; approximate extraction of square root with accuracy to $1/10^n$. Generalization of the concept of exponents. Operations on numbers with any rational exponents.

4. Concept of proportion; the metrical system of measurement, operations with concrete numbers; percent; proportional division.

¹A. N. Kolmogorov, O professii matematika (On the Profession of a Mathematician), 2nd ed., enlarged. Moscow: "Sovetskaya Nauka," 1954.

5. Real numbers; a numbered straight line. Arithmetical and geometrical mean.

6. Absolute value of a real number. General properties of the equality and inequality of numbers.

7. Complex numbers in algebraic form and the four operations on them. Trigonometric form of a complex number.

II. The Conversion of Algebraic Expressions

1. Addition, subtraction, multiplication and division of monomials and polynomials. Formulas of abbreviated multiplication and divisions:

$$(a \pm b)^2; (a \pm b)^3; a^2 - b^2; a^3 \pm b^3$$

2. Resolution of polynomials into factors; the theories of Bezu on the division of whole polynomials into $(x - a)$ form, its application to the resolution of polynomials into factors.

3. Algebraic fractions and operations on them.

4. Operations on radicals. Rationalisation of fractions.

Operations on rational exponents.

III. Equations

1. Identities and equations, their basic properties.

2. Linear equations with one unknown.

3. Systems of linear equations with two and three unknowns.

Analysis of the system of two equations with two unknowns.

4. Equations of the second degree with one unknown. Dependence among the roots of quadratic equations and its coefficients. Analysis of the solution of quadratic equations with real coefficients.

Biquadratic equations. Bi-nomial equations of the 3rd, 4th, and 6th degree.

5. Systems of equations of the second degree with two unknowns (simplest cases).

6. Solution of problems on the composition and solution of equations and systems of equations of all the above-mentioned types.

7. General properties of an inequality. Solution of inequalities of the first degree.

8. Concept of function; dependent and independent variables.

Graphs of the functions:

$$y = kx; y = \frac{k}{x}; y = kx + b; y = ax^2; y = ax^2 + bx + c$$

IV. Progressions

1. Concept of numerical progression; examples of numerical progressions; common term of a numerical progression.

2. Arithmetical progression. Calculation of any term of an arithmetical progression and of the sum of its terms.

3. Geometrical progression. Calculation of any term of a geometrical progression and of the sum of its terms.

4. Concept of the limit of a numerical progression.

An infinite geometrical progression. Determination and calculation of the sum of the terms of an infinitely decreasing geometric progression as a limit.

V. Logarithms

1. Concept of a logarithm. General properties of logarithms.

Graphs of exponential and logarithmic functions.

2. Logarithms of the product, quotient, power, root. Logarithmic expressions. Potentiality.

3. Properties of decimal logarithms. Calculations with the aid of the table of logarithms (4-place).

4. Solution of exponential and logarithmic equations.

VI. The Theory of Combination. Binomial Theory of Newton.

1. Types of combinations: distributions, permutations and combinations (without repetitions). Deduction of numerical formulas, of distributions, combinations and permutations. Proof of the equality:

$$C_m^r = C_m^m - n.$$

Formula of the binomial theory of Newton.

Geometry

I. Plane Geometry

1. Straight line, directed line, segment. Sum and difference of segments of a straight line. Concept of an angle. Sum and difference of angles, properties of vertical angles.

2. The triangle (its medians, altitudes, and bisectors). Types of triangles.

3. Properties of an equilateral triangle. Three indications of the identity of triangles. Theorem on the exterior angle of a triangle.

4. Dependence between the sides and angles of a triangle.

Relationship of perpendiculars and oblique lines. Equality of right-angled triangles.

5. Concept of the geometric position of points. Relation of the perpendicular drawn to a straight-line segment across its middle and the bisector of the angle.

6. Basic problems in construction:

(a) to construct an angle, equal to a given angle, on a straight line through a given point;

(b) to bisect a given angle;

- (c) to bisect a given line segment;
- (d) to construct a perpendicular to a given point on a given line;
- (e) to construct a perpendicular to a given line from a given point;
- (f) to construct a triangle with three given sides, with a side and two adjacent angles, with two sides and the angle between them.

7. Parallel lines. Axioms on parallel lines. Indications of the parallelism of two lines. Through a point, lying outside a line, to construct a parallel to that line.

8. Property of angles with parallel and perpendicular sides. Sum of the angles of a triangle and a polygon.

9. Parallelogram and trapezoid. Properties of the sides and angles of a parallelogram. Properties of the diagonals of a parallelogram. Properties of the diagonals of a parallelogram, rectangle, rhombus, and square.

10. Property of the mean line of the triangle and the trapezoid. Division of a segment into several equal parts.

11. The circle: center, diameter, and radius. Central angles, arcs and their contingent chords. The tangent; properties of a radius drawn to the point of contact. The center of a circle inscribed in a triangle and of a circle circumscribed about it.

12. Measurement of central and inscribed angles; measurement of angles with vertices inside and outside the circle; measurement of an angle composed of a chord and tangent; construction of a tangent to a circle from an exterior point.

13. Concept of commensurate and incommensurate segments.

Proportional segments; properties of parallel lines intersecting the sides of an angle; division of a segment into parts proportional to the given segments; construction of a fourth segment proportional to three given ones.

14. Similarity of triangles and polygons. Construction of a triangle and polygon similar to a given one. Theorems on the similarity of triangles. Theorem on the property of the bisector of the interior angle of a triangle.

15. Metric correlation in a right-angle triangle. Theorems on the perpendicular dropped from the vertex of the right angle to the hypotenuse. The theorem of Pythagoras. The square of the side lying against the acute and obtuse angle of a triangle. Proportional segments in a circle.

Construction of a segment x according to the formula:

$$x = \sqrt{a^2 - b^2} ; x = \frac{ab}{c} ; x = \frac{a^2}{c} ; x = \sqrt{ab}$$

16. Rectilinear polygons. How to inscribe a rectilinear polygon and to circumscribe a circle about it. Similarity of rectilinear polygon of the same class and the ratio of their perimeters.

17. The expression of a side of a square, a rectilinear hexagon and a triangle by the radius of the inscribed and circumscribed circle. Formula for the doubling of the number of sides of a rectilinear inscribed polygon.

18. Computation of the area: of a rectangle, a parallelogram, a triangle, a trapezoid, and a rectilinear polygon. Formula for the area of a triangle expressed by means to the three sides. Theorem on the

ratio of the areas of similar triangles and polygons.

19. The length of the perimeter of the circle as the limit of the perimeters of rectilinear inscribed polygons as the number of their sides are doubled to infinity. Formula for the perimeter of the circle. Concept of the calculation of π . The area of the circle as the limit of the areas of rectilinear inscribed and circumscribed polygons.

II. Solid Geometry

20. The straight line, and the perpendicular to the plane. Representation of the perpendicular straight line to the plane. Theorem of the three perpendiculars.

21. Representations of a parallel straight line and of a plane; of two planes.

22. Angles of two sides. Measurement of angles of two sides by means of linear ones. Perpendicular planes. Representation of the perpendicularity of two planes.

23. The angle between a line and a plane. Intersecting lines and the angle between them.

24. Prisms: the lateral surface of a prism. The parallelepiped, properties of its sides and diagonals, correlation between the diagonal and the three dimensions of a rectangular parallelepiped.

25. The pyramid. Properties of the parallel sections in a pyramid. The total and partial lateral surface of a pyramid.

26. Volume of the prism, the partial and total volume of a pyramid.

27. The lateral surface and volume of the cylinder, cone, and conic sections.

28. The sphere. Sectioning of the sphere by a plane. The plane tangent to the sphere. Great and small circles of the sphere. Surface of the sphere. Surface of a spherical segment and belt. Volume of a spherical sector and of the sphere.

Trigonometry

I. Definitions and Basic Properties of Trigonometric Functions

1. Degree and radian measurement of angles. Positive and negative angles.

2. Definition of the trigonometric functions (sine, cosine, tangent, co-tangent, secant and cosecant) of an arbitrary angle. The change of each of the trigonometric functions in conjunction with the change of the angle from 0 to 2π .

Numerical values of the trigonometric functions for the angles:

$$0; \frac{\pi}{6}; \frac{\pi}{4}; \frac{\pi}{3}; \frac{\pi}{2}; \frac{3\pi}{2}; 2\pi$$

Periodicity of the trigonometric functions.

3. Dependence among trigonometric functions of one and the same argument.

4. General kind of values of the argument, under which a given trigonometric function receives a given value.

5. Reduction of the trigonometric functions of the arbitrary argument to the trigonometric functions of an acute angle.

6. Graphs of trigonometric functions (sine, cosine, and tangent).

II. The Conversion of Trigonometric Expressions and the Solution of Trigonometric Equations

1. Formulas of addition:

$$\sin(\alpha \pm \beta); \cos(\alpha \pm \beta); \tan(\alpha \pm \beta)$$

2. Trigonometric functions of the double and half-angle.

3. Conversion of expressions of the type:

$$\sin \alpha \pm \sin \beta; \quad \cos \alpha \pm \cos \beta; \quad \tan \alpha \pm \tan \beta.$$

4. Reduction of trigonometric expressions to a type suitable for use in logarithms.

5. The simplest trigonometric equations and their solution.

6. The concept of inverse trigonometric functions, their principle values.

III. The Solution of Triangles

1. Logarithmic tables of trigonometric functions.

2. Solution of right-angled triangles.

3. Theorems of sines and cosines. Area of the triangle.

4. Solution of oblique-angled triangles with the aid of the theorems of sines and cosines.

5. The application of trigonometry toward the solution of geometric problems.

APPENDIX C. MATHEMATICS TEXTBOOKS USED IN THE USSR¹

Algebra. Part I

Textbook for the sixth and seventh grades of seven-year and secondary schools.

Approved by the Minister of Education, RSFSR.

Aleksandr Nikolayevich BARSUKOV, author.

State Educational-Pedagogical Publishing House of the Ministry of Education of the RSFSR (Gosudarstvennoye uchebno-pedagogicheskoye izdatel'stvo ministerstva prosveshcheniya RSER-Uchpedgiz), Moscow, Chistyye prudy, 6 [Address], 1956. The book was printed for the above organization by the following organization:

Ministry of Culture, USSR. Main Administration of Polygraphic Production, First Master Printing House imeni A. A. Zhdanova, Moscow, Zh-54, Valovaya, 28. Price for paperback copy: 1 ruble [approximately ten cents] (twenty-five cents official rate). Price for hardback: 1 ruble 75 kopecks. [approximately eighteen cents] (42½ cents official rate).

Chapter I. Algebraic Expressions, Equations

1. Use of Letters
2. Algebraic Expressions
3. Permissible Values of Letters

¹Translated by Walter H. Wallace, U. S. Government Analyst, Washington, D. C.

4. Coefficient
5. Involution
6. Form of Operation
7. Basic Laws of Addition and Multiplication
8. First Information on Equations
9. Brief Historical Data

Chapter II. Rational Numbers

10. Positive and Negative Numbers
11. Numerical Axis
12. Comparison of Rational Numbers
13. Absolute Magnitude of Numbers
14. Addition of Rational Numbers
15. Laws of Addition
16. Addition of Several Numbers
17. Subtraction of Rational Numbers
18. Nature of Addition and Subtraction
19. Algebraic Sums
20. Multiplication
21. Laws of Multiplication
22. Multiplication of Several Numbers
23. Nature of Multiplication
24. Involution
25. Division
26. Nature of Division
27. Graphics
28. Solution of Equations and Problems
29. Brief Historical Data

Chapter III. Operations With Complete Algebraic Expressions

30. Monomial and Polynomial
31. Identities and Identical Transformations
32. Reduction of Similar Numbers
33. Addition of Monomials and Polynomials
34. Subtraction of Monomials and Polynomials
35. Multiplication of Monomials
36. Multiplication of Polynomials by Monomials
37. Multiplication of Polynomials
38. Multiplication of Arrangements of Polynomials
39. Involution of Monomials
40. Formulas for Multiplication Shortcuts
41. General Comments on the Division of Complete Algebraic Expressions
42. Division of Monomials
43. Division of Polynomials by Monomials
44. Division of Polynomials
45. Shortcuts to Division by Means of Formulas

Chapter IV. Separation of Polynomials by Factors

46. Concept of Separation by Factors
47. Placing Common Factors in Parenthesis
48. Methods of Grouping
49. Use of Formulas for Reducing Multiplication
50. Use of Several Methods

Chapter V. Algebraic Fractions

51. Concept of Algebraic Fractions
52. Basic Properties of Fractions

- 53. Change of Signs of Fractional Terms
- 54. Reduction of Fractions
- 55. Reduction of Fractions by a Common Denominator
- 56. Addition of Fractions
- 57. Subtraction of Fractions
- 58. Multiplication of Fractions
- 59. Division of Fractions

Chapter VI. First Degree Equations With One Unknown

- 60. General Information
- 61. Equivalent Equations
- 62. Two Basic Properties of Equations
- 63. Equations Containing An Unknown on Both Sides
- 64. First Degree Equations With One Unknown
- 65. General System for the Solution of Equations
- 66. Solution of Problems With the Help of Equations
- 67. Equations Containing An Unknown in the Denominator
- 68. Concept of Inequalities
- 69. Properties of Inequalities
- 70. Simple Inequalities With One Unknown
- 71. Brief Historical Data

Chapter VII. Equations With Two Unknowns

- 72. Coordinates of Points on a Plane
- 73. Equations with Two Unknowns
- 74. Graphic Description of Equations With Two Unknowns
- 75. Directly Proportional Functions
- 76. Inversely Proportional Functions

77. Linear Functions

78. First Degree Equations With Two Unknowns

Chapter VIII. Systems of First Degree Equations

79. Systems of Two Equations With Two Unknowns

80. Equivalent Systems

81. Solution of Systems of Equations

82. Solution of Problems

83. Equations With Three Unknowns

84. Systems of Three Equations With Three Unknowns

Algebra. Part II

Textbook for the eighth through the tenth grades of secondary schools.

Approved by the Minister of Education, RSFSR, Edition thirty-three.

A. P. Kiselev, author; L. A. Sidorov, editor; N. N. Makhov, tech. editor.

State Educational-Pedagogical Publishing House of the Ministry of Education, RSFSR, Moscow, 1956.

Preface of 20th Edition:

The present edition was printed without modification from the 11th, in which were carried out some modifications compared with previous editions. The principal changes were:

1. Supplemental increase to square of polynomials, analysis of equations and geometrical representation of complete numbers.

2. Some change in the arrangement of the exposition, e.g., the theorems of Bez, of inequality and indeterminate equations is moved from the "Supplement" to the basic course of the book.

3. Considerable increase in the number of exercises.

4. Correction of certain illustrations and addition of some new ones.

In the construction of the present textbook part of the work was done by A. N. Barsukov. From the Publisher:

In the 16th and following editions of the second part of the "Algebra" of Kiselev, the text in Paragraphs six through twelve and in Paragraph 138 is changed, and a number of small errors in different paragraphs are corrected.

In the 24th edition, in accordance with requests, the theme "Complex Numbers" is supplemented: Paragraph 140s and Paragraph 140t - trigonometric form of complex numbers. The themes "Analysis of Quadratic Trinomials" and "Inequalities of the Second Degree"; Paragraphs 182 - 187 were added too.

The supplemental material was written by A. N. Barsukov.

The present edition (thirty-three) was printed without change from the previous (thirty-two) edition.

Chapter I. Identical Transformations With Powers and Roots

1. Increase in Power
2. Increase in Square of Polynomial
3. Concept of Irrational Numbers
4. Transformation of Irrational Expressions
5. Irrational Equations

Chapter II. Functions and Their Graphs

1. Functional Dependence
2. Straight Line and Inverse Proportionality
3. Linear Functions

Chapter III. Quadratic Functions

1. Additional Information Concerning Quadratic Equations
2. Graphs of Quadratic Functions
3. Systems of Equations of the Second Degree

Chapter IV. Inequalities

1. Inequalities of the First Degree

Chapter V. Progressions

1. Arithmetic Progressions
2. Geometrical Progressions
3. Infinite Progressions

Chapter VI. Generalization of Ideas Concerning Exponents

1. Purpose of Exponents
2. Fractional Exponents
3. Concept of Irrational Exponents
4. Exponential Functions

Chapter VII. Logarithms

1. General Properties of Logarithms
2. Properties of Decimal Logarithms
3. Arrangement and Use of Tables
4. Exponents and Logarithmic Equations

Chapter VIII. Analysis of Equations

1. Analysis of Equations of the First Degree with One Unknown
2. Analysis of Systems of Two Equations of the First Degree with

Two Unknowns

3. Analysis of Quadratic Equations

Chapter IX. Imaginary and Complex Numbers

Chapter X. Some Information Concerning Algebraic Equations

1. Divisibility of Polynomials

Chapter XI. Indeterminate EquationsChapter XII. Combinations and Newtonian Binomials

1. Combinations
2. Newtonian Binomial

Supplement [Note: No Chapter Number - Translator]

1. Continued Fractions
2. Concerning Limits
3. Analysis of Quadratic Trinomials. Inequalities of the Second

Degree.

Elementary Geometry Course For Tekhnikums

P. P. Andreyev, author.

4th Edition (100,000 copies) stereotyped

Authorized by the Administration of Secondary Special Educational Institutions of the Ministry of Higher Education, USSR, as a textbook for secondary special educational institutions.

State Publishing House of Technical & Theoretical Literature, Moscow, 1957.

PLANE GEOMETRY

Chapter I. Proportionate SegmentsChapter II. Similarity of Figures [Forms]

1. Perspective-Congruent Conversion
2. Congruent Figures
3. Similarity of Triangles
4. Similarity of Polygons

Chapter III. Metric Relationships in a Triangle and in a Circle

1. Metric Relationships Among Elements of a Triangle and of a Parallelogram

2. Metric Relationships in a Circle

Chapter IV. Rectilinear Polygons and Calculation of the Circumference

1. Rectilinear Polygons

2. Construction of Certain Rectilinear Polygons, Inscribed in a Circumference and Calculation of Their Side

3. Calculation of the Length of the Circumference

Chapter V. Measurement of Areas

1. Equidimensional and Equiconstructed Polygons

2. Area of Polygons

3. Ratio of Areas of Rectilinear Figures

4. Transformation of Polygons into Equidimensions

5. Area of a Circle and its Parts.

SOLID GEOMETRY

Chapter VI. Straight Line and Plane

1. Basic Concepts

2. The Perpendicular and Oblique to a Plane

3. Parallel Straight Lines and Planes

4. Parallel Planes

Chapter VII. Dihedral Angles, Perpendicular Surface and Polyhedral Angles

1. Dihedral Angles

2. Perpendicular Surfaces

3. Area of Projection of Plane Figure

4. Trihedral and Polyhedral Angles

Chapter VIII. Polyhedrals

1. Prism
2. Pyramid

Chapter IX. Circular Bodies

1. Cylinder
2. Cone
3. Sphere

Answers

1st edition was published in 1952

APPENDIX D. EXAMPLES OF PROBLEMS USED IN SOVIETMATHEMATIC "OLYMPIC GAMES"

1. Solve this system of fifteen equations with fifteen unknowns:

$$\begin{aligned}
 1 - x_1x_2 &= 0 \\
 1 - x_2x_3 &= 0 \\
 1 - x_3x_4 &= 0 \\
 &\dots\dots\dots \\
 1 - x_{14}x_{15} &= 0 \\
 1 - x_{15}x_1 &= 0
 \end{aligned}$$

2. 500 boxes contain apples. It is known that no box can hold more than 240 apples. Prove that at least 3 boxes each contain the same number of apples.

3. How many zeros are there in $50! = 1.2.3.4\dots 49.50$?

4. How many times in twenty-four hours are the hands of a clock perpendicular to each other?

5. Factor the expression: $x^5 \nmid x \nmid 1$

6. What is the largest possible number of acute angles that a convex polygon with n sides can have?

7. Factor the expression: $a^{10} \nmid a^5 \nmid 1$

8. Solve the system of equations:

$$\begin{aligned}
 xy(x \nmid y) &= 30 \\
 x^8 \nmid y^8 &= 35
 \end{aligned}$$

9. Two regular tetrahedrons are placed within a cube in such a manner that four apexes of the cube are also apexes of one of the tetrahedrons and the remaining four apexes of the cube are the apexes of the second

- tetrahedron. What part of the cube's volume is occupied by the volume of the part common to both tetrahedrons?
10. A space quadrangle is circumscribed about a sphere. Prove that the points of tangency are in one plane.
11. Prove that there can be no seven-edged polyhedron.
12. Numbers 1, 2, 3, ..., 101 (altogether 101 numbers) are placed in a series of unknown order. Show that 90 of these numbers can be struck out so that the remaining integers will occur either in descending or ascending order of magnitude.
13. Prove that the straight lines from the mid-point of the altitude of a regular tetrahedron to the apexes of its base are mutually perpendicular.
14. Prove that the sum of the distances from any point within a regular tetrahedron to its faces is a constant.
15. Prove that if $n > 1$ then
- $$2 < \left(1 + \frac{1}{n} \right)^n < 3$$
16. Prove that, if a is any whole number, $a^7 - a$ is divisible by 42.¹

¹A. N. Kolmogorov, O professii matematika (On the Profession of a Mathematician), 2nd ed., enlarged. Moscow: "Sovetskaya Nauka," 1954.

Professor Kolmogorov, one of the best known mathematicians in the Soviet Union, is Dean of the Mechanics-Mathematics Faculty, Moscow University, and a member of the USSR Academy of Sciences.

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Mr. Bolser taught mathematics in the high schools of Atlanta, Georgia, from 1935 to 1943, when he entered military service.

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This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of that committee. It was submitted to the Dean of the College of Education and to the Graduate Council, and was approved as partial fulfillment of the requirements for the degree of Doctor of Education.

January 31, 1959

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